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THESIS

A UNIQUE PROTOTYPING CONCEPT FOR MISSILE AND AVIATION WEAPON SYSTEMS

by

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December 2002

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13. ABSTRACT *(maximum 200 words)*

This thesis is a case study into the development of a unique prototyping concept to support aviation and missile weapon system requirements. The U.S. Army Aviation and Missile Command has an electrical and mechanical prototyping capability that has existed for twenty-five years, but has been geographically and functionally separated. These capabilities have been integrated both functionally and geographically, into the Prototype Integration Facility, Building 5405, at Redstone Arsenal, Alabama. Aviation and missile program managers are faced with the increased challenge to acquire materiel in a in a more cost effective, timely manner. The Prototype Integration Facility (PIF) concept builds off the foundation of the existing base of prototyping experience, but integrates unique business principles to form a creative, powerful concept to assist aviation and missile program managers in their quest to rapidly provide materiel to the warfighter. The primary tenants of the PIF concept include the leveraging of existing Governmental and industrial capabilities to provide a cost effective alternative for program managers to utilize. The PIF concept utilizes a ten-year, $1.1 billion contract, to leverage the capabilities of original equipment manufacturers, capability-specific companies and small businesses. Since implementation of the PIF concept in June 2002, an influx of $18 million of aviation and missile prototyping business has been achieved.

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A UNIQUE PROTOTYPING CONCEPT FOR MISSILE AND AVIATION WEAPON SYSTEMS

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ABSTRACT

This thesis is a case study into the development of a unique prototyping concept to support aviation and missile weapon system requirements. The U.S. Army Aviation and Missile Command has an electrical and mechanical prototyping capability that has existed for twenty-five years, but has been geographically and functionally separated. These capabilities have been integrated both functionally and geographically, into the Prototype Integration Facility, Building 5405, at Redstone Arsenal, Alabama. Aviation and missile program managers are faced with the increased challenge to acquire materiel in a in a more cost effective, timely manner. The Prototype Integration Facility (PIF) concept builds off the foundation of the existing base of prototyping experience, but integrates unique business principles to form a creative, powerful concept to assist aviation and missile program managers in their quest to rapidly provide materiel to the warfighter. The primary tenants of the PIF concept include the leveraging of existing Governmental and industrial capabilities to provide a cost effective alternative for program managers to utilize. The PIF concept utilizes a ten-year, $1.1 billion contract, to leverage the capabilities of original equipment manufacturers, capability-specific companies and small businesses. Since implementation of the PIF concept in June 2002, an influx of $18 million of aviation and missile prototyping business has been achieved.

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I. INTRODUCTION

A. PURPOSE

This research will analyze the methodologies and philosophies utilized by Aviation and Missile Research, Development and Engineering Center (AMRDEC), U.S. Army Aviation and Missile Command (AMCOM) personnel to develop a unique prototyping strategy to better support aviation and missile weapon system requirements.

B. BACKGROUND

Weapon system program managers are continually facing the challenges associated with the execution of rapid development of their weapon systems within program budgets that, at best, remain fixed, but that in most cases are actually reduced. This challenge, compounded with the transformation of the Army to a lighter, more flexible, and more rapidly deployed force, created the need to examine potential alternatives to the more traditional means of materiel development. In 2001, the AMCOM AMRDEC initiated efforts to craft a prototyping strategy that would aid both weapon system program managers and the Army in their quest. This research will depict how the AMRDEC prototyping strategy is assisting weapons system program managers in providing the opportunity to deploy materiel to soldiers both quicker and at a more efficient cost.

C. RESEARCH QUESTIONS

The primary research question for this thesis is:

- What are the primary tenants of the unique prototyping strategy developed at AMCOM and what benefits will it provide to aviation and missile weapon systems?

The following are subsidiary research questions to help develop and define the primary research question:

- What business and capability impacts does the AMRDEC prototyping strategy have on the AMRDEC as a whole?
- What impact does the AMRDEC prototyping strategy have on other AMCOM and AMCOM tenant organizations?
- What is the relationship that exists with industry as a result of implementation of the AMRDEC prototyping strategy?

- What cultural barriers were encountered during the implementation of the AMRDEC prototyping strategy and how were they overcome?
- How does the AMRDEC prototyping strategy fit within the new Research, Development and Engineering Command within the Army Materiel Command?

D. SCOPE OF THESIS

The scope of the thesis will include 1) the independent description of the prototyping efforts that existed at AMCOM prior to the development of the current strategy; 2) the influences on the weapon system program managers that formed the basis for the need of the AMRDEC prototyping strategy; 3) the major tenants, challenges, and benefits to date of the AMRDEC prototyping strategy; and 4) the potential for application of the AMRDEC prototyping strategy as a model in other Army organizations.

E. METHODOLOGY

Data was gathered through personal interviews with AMCOM and Program Executive Office (PEO) personnel involved in the development of the AMRDEC prototyping strategy. A comprehensive analysis of the information gathered with respect to the AMRDEC prototyping strategy and its impact to missile and aviation program managers was performed. A synthesis analysis was performed with business and readiness considerations to depict the results to date of the implementation of the AMCOM prototyping strategy and offered recommendations for potential improvements.

F. ORGANIZATION

Chapter II depicts the AMRDEC prototyping strategy that existed previous to the current strategy.

Chapter III identifies the influences and challenges faced by program managers that lead to the development of the AMRDEC prototyping strategy.

Chapter IV provides a description of the major tenants, challenges, and benefits to date of the AMRDEC prototyping strategy, including those for facilities, contracts, personnel, organizational structure, and culture.

Chapter V provides conclusions and recommendations and highlights other areas for further research.

G. BENEFITS OF STUDY

The proposed thesis will provide weapon system program managers with a model of how to utilize a unique prototyping strategy as a more cost-effective alternative for the acquisition of materiel.

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II. AMCOM PROTOTYPING STRATEGY PRIOR TO THE DEVELOPMENT OF THE PROTOTYPE INTEGRATION FACILITY CONCEPT

A. INTRODUCTION

The purpose of this chapter is to depict the AMCOM prototyping strategy that existed prior to the development of the current Prototype Integration Facility (PIF) strategy. It will serve to establish the foundation for how the PIF concept emerged from an extensive base of prototyping experience.

B. HISTORY

The AMCOM prototyping capability was based in large part upon two capabilities that are segregated between two divisions within the Engineering Directorate of the AMCOM AMRDEC. The capabilities are divided between mechanical and electrical fabrication and assembly. The Prototype Engineering Division (Skunk Works) has in the past provided the DOD community with mechanical prototyping capabilities, while the Manufacturing, Science, and Technology Division's, Engineering Analysis Prototype Lab (EAP Lab) provided the DOD electrical prototyping capabilities. The Engineering Directorate organizational structure depicting the Prototype Engineering Division and the Manufacturing, Science, and Technology Division is shown at Figure 1.

The Prototype Engineering Division was established in the mid 1970s and has since provided mechanical fabrication and integration support to missile system project offices. Mechanical capabilities offered by the Prototype Engineering Division included milling, joining, cutting and conventional machining. Originally, the Prototype Engineering Division was comprised of ten to fifteen Government personnel and was housed in a 30,000 square foot facility built in the 1950's. With rapidly increasing workloads in the mid 1980s, it became necessary to outsource through the award of Time and Materials (T&M) contracts to support the demand for fabrication work. During the next 12 years, additional follow-on T&M contracts of the same type were awarded due, in large part, to the downsizing of the Government workforce. The funding ceilings for these contracts did not exceed $5 million. The Prototype Engineering Division's primary customers were the PATRIOT and Multiple Launch Rocket System Project Offices. In

addition, the Prototype Engineering Division fabricated test fixtures to support live fire testing for many tactical missile programs.

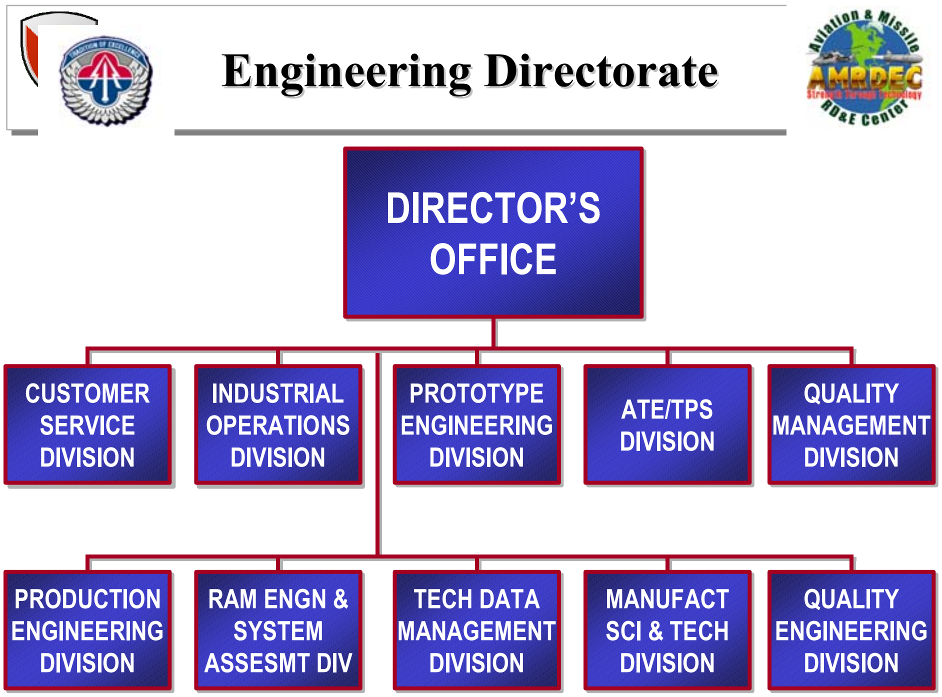

Figure 1. Engineering Directorate Organizational Chart.

The EAP Lab was established in the early 1970s to provide electrical fabrication and assembly support to the missile system project offices. Engineering, Analysis and Prototyping Lab capabilities included design and reverse engineering for electronic circuit cards, cables, and wiring harnesses. The EAP Lab was comprised of six to eight Government personnel and was housed in various locations throughout the AMRDEC's building 5400.

The EAP Lab also was severely affected by attrition in the late 1980s, to the point that outsourced contract support was required. In 1990, a T&M contract was awarded with a ceiling of $3 million and duration of 5 years. By this time, the Electronics Lab's customers and funding continued to increase approximately 25% percent each year, leading to new business strategies and additional contract awards. By mid 2001, the EAP Lab's continued growth, caused by increased customer business, forced the fabrication and engineering contracts to reach their ceiling limits prematurely. Through EAP Lab

management efforts to set new goals, priorities, and business strategies for the Electronics lab, the fabrication and engineering functions were combined and announced for a competitive, 8(a) solicitation for those increased contract ceiling requirements. In January 2001, a $23M contract was awarded to support the EAP Lab.

The Prototype Engineering Division and the EAP Lab operated as autonomous organizations throughout their existence with little desire or motivation to integrate their capabilities. This situation was exacerbated by the geographically-dispersed locations of the organizations and the ability of both of these organizations to acquire additional, needed capabilities that did not currently exist in their respective organizations, through their newly-awarded support contracts. This resulted in an inefficient duplication of capabilities. As an example, the EAP Lab would contract out for mechanical capabilities such as milling and machining of boxes that housed various circuit card assemblies and wiring harnesses. Likewise, the Prototype Engineering Division would contract out for cable and wiring harness needed to support the development of various tactical operations centers. Both the Prototype Engineering Division and the EAP Lab were content to continue this operational concept with little thought given to the opportunities and benefits associated with the integration of each organization's capabilities. In addition, EAP and Prototype Engineering Division business strategies were diametrically opposed. The Prototype Engineering Division strategy was to simply maintain the business base that had sustained them for the past ten to fifteen years. Opportunities for growth occurred only by word-of-mouth or through increased business from existing missile system project offices. There were no plans to target any new missile or aviation project offices as a means to achieve business growth. The EAP Lab, on the other hand, had already achieved a significant level of growth due to selective marketing to both missile and aviation system project offices and sought out opportunities to the extent that facilities and contract cost ceilings would permit. In addition, the EAP Lab worked with AMCOM organizations responsible for the management of the command Operation and Support Cost Reduction (OSCR) program to perform the nonrecurring engineering, and qualification of approved OSCR projects that supported missile and aviation system project offices. This innovative concept, in effect used Army Materiel Command (AMC) OSCR funding to support the reduction of support costs by various system project

offices, such as the PATRIOT and Kiowa Warrior project offices, at significantly reduced costs compared to other alternatives. Weapon systems were afforded a reduction in support costs through non-program funds and at a much more efficient cost. The EAP Lab, through this initiative, strengthened their value to the missile community, but more importantly, achieved credibility within the Aviation Program Executive Office.

C. THE CHANGING ENVIRONMENT

In the late 1990's, the Director of the Engineering Directorate required functional integration of the capabilities of both organizations. Efforts were made to consider the use of each organizations capabilities when project office tasks bids were being developed. For example, the Prototype Engineering Division incorporated EAP Lab cabling estimates into their bid to provide various shelter modifications for the PATRIOT project office. The EAP Lab utilized box-machining estimates from the Prototype Engineering Division as a part of their bid to the Test Measurement Diagnostic Engineering Activity to prototype electronic test boxes. As a result, the Prototype Engineering Division and the EAP Lab began to work together, and funding levels for both organizations grew and project offices were receiving a more efficient level of support.

It was at this time that the nature of the tasks requested by project office customers began to change. Both missile and aviation system project offices were soliciting more extensive, complex types of prototyping. The EAP Lab, while still being utilized extensively for circuit board and cabling tasks, was being asked to build complex diagnostic boxes, capable of testing entire families of hardware. The Prototype Engineering Division began to receive more interest from project offices to renovate shelters and tactical operations centers verses the build of piece-parts and test fixtures. The business profile for both the Prototype Engineering Division and the EAP Lab that had existed prior to the initiation of the PIF concept had also changed. A combined funding base of $1.5 million in 1996 grew to $10 million per year of new business in 2001. In addition, larger and more complex tasks from aviation and missile system project offices were being performed, which necessitated closer working relationships between the two organizations.

D. SUMMARY

The AMCOM has a long history of providing prototyping capability to meet project office requirements. This prototyping capability, however, had been fragmented and disjointed and as a result had not provided the best possible product to project offices. While progress has been made in integrating the electrical and mechanical prototyping capabilities that existed within the Engineering Directorate, significant opportunities for increased support due to the changing Department of Defense acquisition environment were being missed while this operational prototyping concept was in effect.

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III. PROGRAM MANAGER CHALLENGES AND INFLUENCES SUPPORTING THE DEVELOPMENT OF THE PIF CONCEPT

A. INTRODUCTION

The purpose of this chapter is to identify the influences and challenges faced by weapon system program managers that provided the opportunity for the development of a unique prototyping support capability such as that of the PIF concept. This chapter will address both the traditional challenges faced by weapon system program managers, as well as new challenges driven by recent events, as they balance the complex process of managing the acquisition of materiel to support the warfighter. These challenges include those posed by the reduction of defense budgets in the post-Reagan-build down and the resulting decrease in readiness of aviation weapon systems, the current DoD and Army transformation initiatives, and the normal cost, schedule, and performance tradeoffs.

B. DEFENSE BUDGET HISTORY

Present day program managers continue to battle the legacy left by the decrease in defense spending over the past fifteen years, particularly in defense procurement accounts. Figure 2 (Reference 1.) shows that from 1985 to 2001, defense procurement decreased by thirty-four percent.

This funding decrease, while negatively affecting procurement programs from every Service, had an indelible impact on Army aviation programs. As a result, the Army is now required to modernize the current aviation fleet at a significant cost. The Army will also reduce the total number of aircraft in the active force by more than 400 in the reserve forces by more than 600 as a means to minimize modernization costs. This will include accelerating the retirement of the Vietnam-era UH-1 “Huey” helicopters and AH-1 Cobra attack helicopters. The acceleration will divest Army aviation of these “legacy” aircraft by 2004. By the end of 2004 the operational fleet will consist of only four types of helicopters: the AH-64 Apache, the UH-60 Blackhawk, the OH-58 Kiowa, and the CH-47 Chinook. (Reference 2.) By 2004, the AH-64 Apache will have been in use by the Army for 20 years, the UH-60 Blackhawk 26 years, and the Ch-47 Chinook 34 years. And, because fielding of the Comanche system has been slipped to 2008, the OH-58 Kiowa will remain a key capability in the Army’s aviation programs for several years to

come. The resulting stress on the readiness of an already aging fleet of aviation systems, created a situation where aviation program managers are presently required to manage modernization programs that include provisions for increased readiness levels that ameliorate the significant decline in readiness that has occurred in the last ten years. Many of the aviation modernization efforts, such as those to install common transponder radios into the OH-58 Kiowa, do not involve large complex efforts, and as such, lend themselves for adoption of non-traditional means of acquisition.

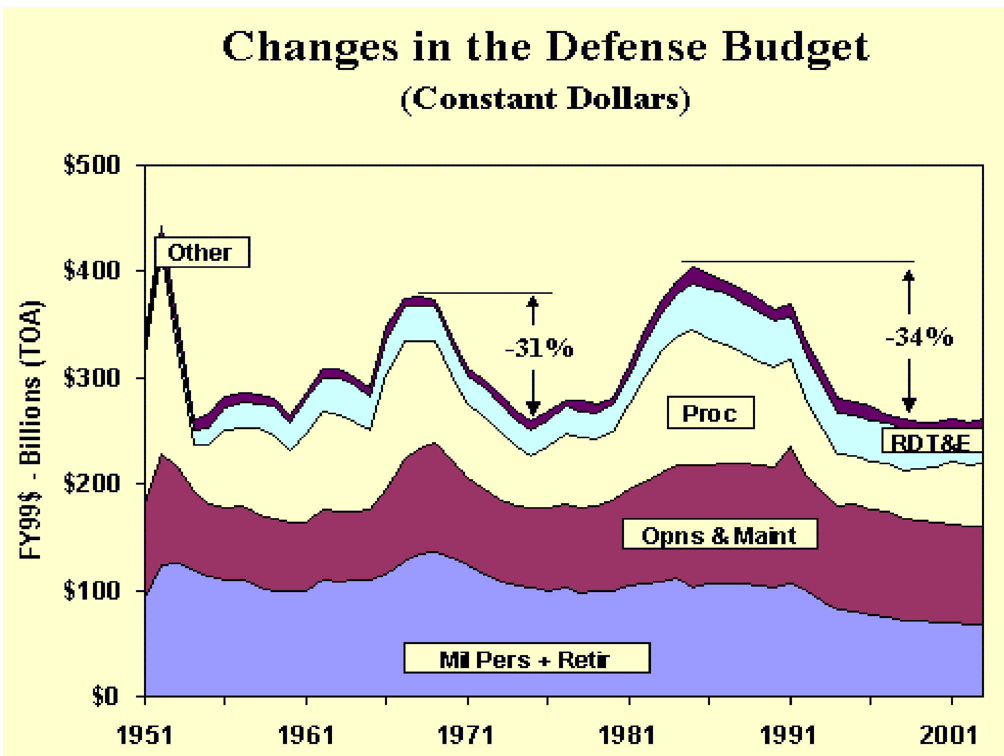

Figure 2. Changes in the Defense Budget.

C. DOD AND ARMY TRANSFORMATION

The DoD and the Army are both undergoing significant change through transformation programs. This transformation was initiated early in 2000 and became more focused after the events of September 11, 2001.

One of the President's key defense priorities is to transform America's armed forces to perform their missions more effectively and to meet emerging security challenges. The Defense Department began the process of transformation with its 2001

Quadrennial Defense Review. This review shifted to a "capabilities-based" defense strategy that focuses on the capabilities of potential adversaries and the tools that America's armed forces will need to deter and defeat adversaries employing those capabilities. Both the terrorist attacks of September 11, 2001, and the subsequent conduct of Operation Enduring Freedom in Afghanistan, underscore the urgency of military transformation. They illustrate the need for America's military to prepare for different types of conflict and execute missions with new tactics and new technologies. The growing use of unmanned aerial vehicles, the effective utilization of real-time intelligence, and the coordination among special operations and allied forces all demonstrate the cutting edge of what military transformation can achieve and offer a glimpse of a future transformed joint force. (Reference 3.)

The Department of Army has created their transformation strategy to conform to that of the President and the DoD. Army Transformation focuses on delivering land power capabilities to meet 21st Century strategic requirements, and rests squarely within emerging joint operational concepts and capabilities. More than building and procuring new systems and platforms, Army transformation combines advanced technologies, organizations, people, and processes, with concepts to create new sources of military power that are more responsive, deployable, agile, versatile, lethal, survivable, and sustainable. The Army will integrate its development efforts for these new capabilities with those of the joint community, and assess them through joint and Service experimentation. This process will produce increasingly responsive capabilities and dominant formations that are modular and scalable. (Reference 4.) Figure 3 depicts the Army's three-pronged approach to transformation. (Reference 5.)

The Legacy Force is the Army as it is currently configured and is what guarantees near- term warfighting readiness to support the National Military Strategy. To sustain a force that provides the necessary combat overmatch at an affordable price, the Army must rebuild and selectively upgrade legacy force systems. This "recapitalization" and modernization effort will return selected systems to like-new condition and extend Army capabilities into the future. (Reference 5.) Modernization and recapitilization of the AH-64 Apache, the UH-60 Blackhawk, the Ch-47 Chinook, and the PATRIOT missile systems to sustain the Army until fielding of Interim and Objective Force capabilities

present program managers of these systems with the need to achieve their fielding objectives in a timely manner so as to sustain the warfighter. An example of the benefit of utilizing an alternative such as the PIF has been provided from a modernization perspective. The PIF alternative also has potential as aviation and missile weapon systems are recapitalized as well. The use of a "best-value" approach to recapitilization, through the recognition of each component as a separate entity, and the use of alternative contracting mechanisms, presents program managers with an option to original equipment manufacturer (OEM) management of recapitalization programs. In addition, the need for rapid development and deployment of the objective force system lends itself to the use of alternative procurement strategies to meet the fielding requirements as directed by the Department of Army and DoD.

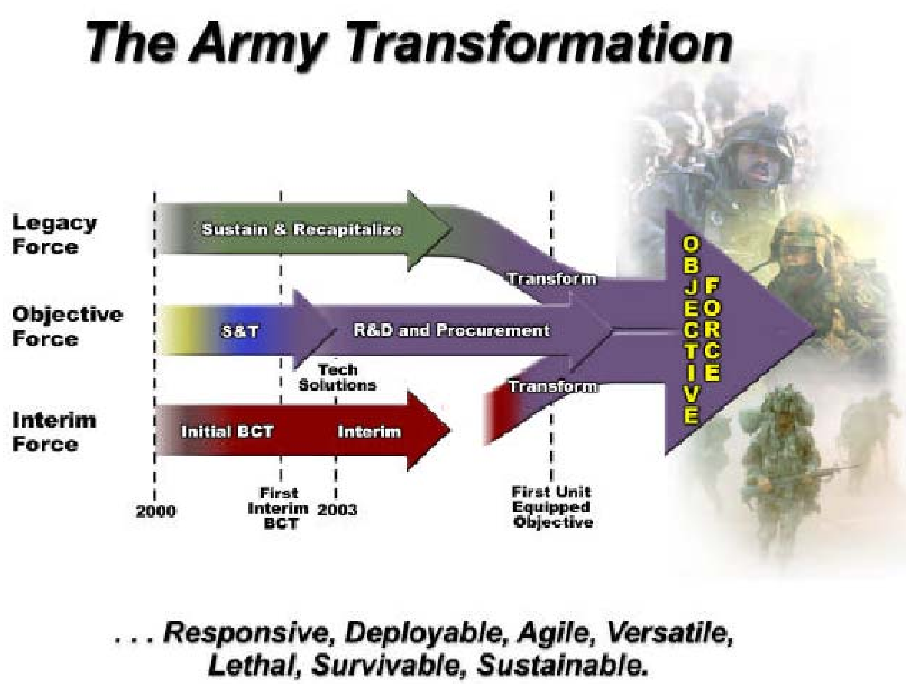

Figure 3. Army Transformation.

D. COST, SCHEDULE, AND PERFORMANCE

Program managers are charged to design, develop, fabricate, integrate, test, and field a system or systems in the fastest, most economical means possible. The challenge for the program manager to balance the tradeoffs between cost, schedule and performance has become even greater given the changed environment that exists today.

While performance may remain a fairly stable requirement to a program manager, opportunities to influence cost and schedule tradeoffs exist because of conditions that have emerged in the last five to ten years. These conditions include OEMs with high overhead rates and who do not have the time to work non-recurring type efforts, and the lengthy procurement process. Program managers that are strapped with an OEM with a high overhead rate will be faced with the prospect of procuring reduced system quantities. The lengthy procurement process that program manager's face often impacts the system schedule including fielding milestones. These conditions create both cost and schedule impacts on a program manager and the need to consider other alternatives as mitigating measures.

E. SUMMARY

Program managers are required to weigh many factors in the course of managing their systems. The traditional pressures of managing cost, schedule, and performance have increased due to the increase in activity associated with declining defense budgets and the DoD and Army transformation activities. This additional pressure has created the prospect for program managers to consider alternative means of acquiring the systems for which they are responsible. The PIF concept is one of the alternatives available to program managers as they acquire their system.

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IV. THE PIF CONCEPT

A. INTRODUCTION

This chapter will describe the PIF concept, including its structure, challenges, and benefits provided to program managers to date. The business strategy, organizational structure, facilities, contractual, and capability elements associated with the PIF will be discussed in detail.

The name PIF, Prototype Integration Facility, is a misnomer in that the PIF is more than a facility. It is a strategy with many facets and the ability to touch disparate aspects of the acquisition process, and is built upon the foundation of prototyping experience that has existed at AMCOM for the past twenty-five years. The PIF concept was built exclusively around being a value-added prototyping capability for program managers, by leveraging the most cost effective expertise available to meet a weapon system requirement. The achievement of this objective was based upon the fundamental ability of Engineering Directorate prototyping personnel to establish partnering agreements with several different organizations, both in Government and industry, through the identification of a unique business strategy that would be of benefit to all involved. In addition, the traditional use of facilities, personnel, and contracting strategies were altered to support the PIF concept.

B. BUSINESS STRATEGY

The PIF was established to provide a rapid, in-house response capability for weapon system solutions. The PIF is a Government-Owned, Government-Operated (GOGO) capability that provides customized and fully integrated turnkey solutions via unprecedented design and engineering expertise, rapid prototyping, mechanical fabrication, circuit card assembly, cables and chassis build-up, platform integration, advanced manufacturing technologies, and program management, to support program manager's requirements to get the product in the hands of the soldier by the most expedient means possible.

From multi-functional, multi-faceted integration projects, to simplistic machining and fabrication, the PIF has been able to build prototypes, few-of-a-kind, and limited

production hardware, to the highest Government and industry standards. The PIF has offered the customer a "One Stop Shopping" environment that ensures the warfighter the absolute best technical solution, at the best price and level of quality, and one that adheres to the schedule. Prototype Integration Facility hardware integration has been executed by utilizing the integrated product team methodology, with specialists from each PIF organizational element, to include Government teaming arrangements with industry partners. The PIF organizational and operational concept has provided for an unparalleled simplicity when compared to the normal acquisition and programmatic arenas. The PIF organizational structure and contractual vehicles have offered the customer virtually unlimited programmatic flexibility.

The PIF marketing strategy took advantage of the geographic proximity of the PIF to three major Army program executive offices (PEOs): Air and Missile Defense (AMD), Tactical Missiles (TM), and Aviation. The AMD and TM PEOs had been doing an extensive amount of business with the prototyping organization prior to the formulation of the PIF concept. The prospects for additional business in both of these PEOs, along with other established customers, such as the Marine Corps and the Test, Measurement, and Diagnostic Engineering Activity, were excellent. The Aviation PEO, however, provided the most extensive opportunity for the PIF. The PIF strategy in this area was to take advantage of the many capabilities in an Army Aviation Corridor of Excellence (AACE), bounded by Redstone Arsenal and the U.S. Air Force's (USAF) Arnold Engineering Development Center in the north, and Eglin Air Force Base's 46th Test Wing capability, and the U.S. Army Aviation Center at Ft. Rucker in the south. The depth of knowledge and experience in many specific areas throughout the AACE would provide efficient and responsive accomplishment of many of the tasks faced by the PIF. Utilizing the AACE integrated the total aviation community, and supported optimized capital investment for the Government as well as industry. It not only provided for continuous, comprehensive evaluations, but also made full spectrum testing more affordable.

A key strategic element of the PIF concept was to make it as easy as possible for weapon system managers to do business with the PIF. A top-level process was

developed, that took advantage of customer inputs and past experiences. Figure 4 shows the PIF execution strategy that was developed and utilized (Reference 6.)

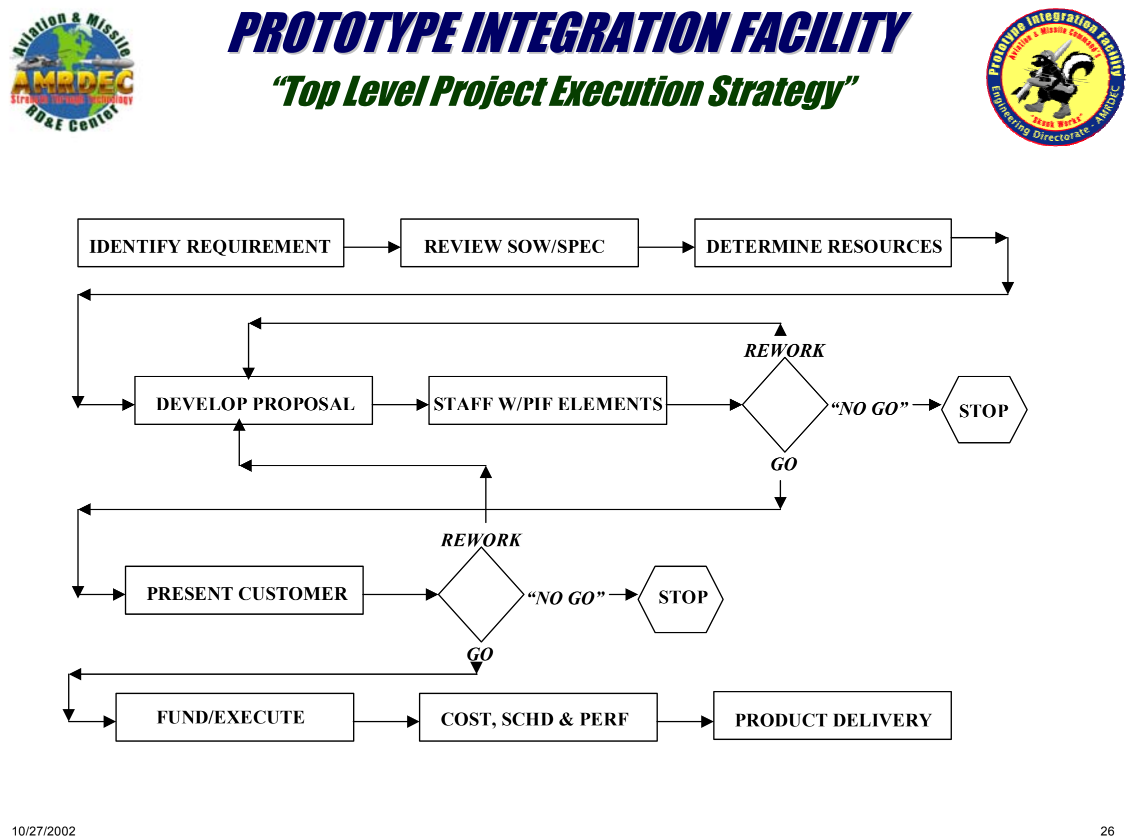

Figure 4. PIF Execution Strategy.

The first step in doing business with the PIF is to identify the need or requirement. In the aforementioned paragraphs, the PIF's marketing strategy briefly discussed how the PIF planned to market its capabilities and grow the PIF business base. In addition to customers coming directly to the PIF, the PIF has been in a position to propose efforts to accomplish upgrades and known modification requirements, as well as solutions for known problems. A constant liaison with potential customers, such as the Assistant Project Managers, Product Managers, Program Managers, the Integrated Materiel Management Center (IMMC), and AMRDEC elements, have allowed the PIF to propose assistance relatively soon after a need or requirement materializes.

The next step in the PIF execution process has been to define the requirement. The primary focus of the PIF concept has been to offer the customer a Government-to-Government interface where open communication can flow freely to properly define the requirement or project. Through utilization of the Alpha Contracting methodology, the PIF has worked hand-in-hand with the customer to develop a viable acquisition approach. In those instances where the requirement has not been accurately documented, i.e., existing Statement of Work (SOW), the PIF has been required to draft all acquisition documentation, with input from the customer. As required, and prior to release of proposal, the PIF Project Management Team has required physical viewing of hardware, host platforms, Government-Furnished Equipment/Property (GFE/GFP), performance specifications, technical manuals, and technical data packages (TDPs), all in an effort to maximize the quality of the proposal cost estimate.

The assembly of the proposal development team is the third step in the PIF execution process. The PIF Program Manager (PM) Team Leader has served as the focal point and IPT lead for proposal development. As requirements have been finalized, the PM Team Leader has formalized the necessary personnel, skills, and support to complete the requirement. Once the customer feels comfortable with the SOW or requirement, the PM Team Leader assembles the necessary PIF elements required to develop a proposal or Rough Order of Magnitude (ROM) estimate.

The fourth step in the PIF execution process is to determine the required resources. The PIF PM Team Leader is the ultimate authority for determining the resources necessary to develop the proper teaming arrangement with the PIF's Government and industry partners. This has included review of the design and analysis of requirements, modeling and simulation capabilities, development, design and test facilities required, hardware capabilities and fabrication assets, System Integration Laboratories (SIL), environmental testing/qualification, assembly, integration facets, and air-worthiness considerations. The primary goal of the PIF PM Team Lead has been to assemble the necessary capabilities and resources to propose the recommended mix based upon the most effective source. Where feasible, the goal of the PIF has been to assemble the best possible team at a fair and reasonable price to meet customer needs and to

perform as much work as possible within the confines of the PIF Facilities or existing Government infrastructure.

The development of the PIF proposal is the next step in the PIF execution process. The PIF PM Team Lead is fully responsible for project planning, proposal preparation, management, scheduling, and execution activities and serves as IPT lead for the proposal development team. The PIF PM Team Lead collects, analyzes, and interjects all cost data from sources external to the PIF. In the event PIF in-house resources have not been adequate to fulfill the customer's needs, the contractor program manager, serving on the IPT, has been tasked to develop a Technical Directive Execution Plan (TDEP). The Contracting Officers Representative (COR), issues a request for TDEP to the contractor. Unless otherwise delineated by the Procuring Contracting Officer (PCO), the PCO and COR are the only individuals authorized to issue such requests. The contractor responds only to requests from these authorized individuals. Within seven calendar days of receipt of the Technical Directive SOW, the contractor submits a TDEP to the COR or his designated representative. The contractor provides, as a minimum, several types of information. This includes a complete and concise description of the technical approach, to include, but not limited to, proposed subcontractors and facilities to satisfy the requirements of the technical directive SOW. The contractor addresses all applicable elements of the overarching technical support for the PIF Statement of Work, and identifies the labor allocation mix, total hours inputted to each labor category, as well as the company labor category and the number of hours for each individual assigned to the labor category for the specific TDEP. The contractor also provides one page resumes for each assigned individual for review and approval prior to commencement of work. The contractor provides cost breakdowns by labor, materials, other direct costs (ODC) and total TDEP cost. Material costs provided identify raw materials and any associated material handling charges, as applicable, and describe the nature and cost associated with each ODC. Finally, the contractor develops and provides a program schedule (e.g., GANTT chart) that identifies, but is not limited to, start and completion dates for all critical technical directive tasks and sub-tasks.

The next step in the PIF execution process is to staff the final proposal through PIF management to insure that the proposal is complete and presents an accurate,

executable strategy to the customer. At this point, the proposal/ROM is ready for presentation to the customer. This may be accomplished via email, formal briefings, or hand-carry to customer, and is determined by the desires of the customer, but also is influenced by the size of the project and level of PIF commitment required, and precedents, which may have been previously established. At this point, an open communication environment exists and negotiations to secure the project have normally ensued. In cases where negotiations have resulted in major changes, a reworked proposal/ROM is resubmitted to the customer. The goal has been to offer the customer flexibility to allow the PIF to accomplish all or parts of a customer's requirements.

Once the customer approves the PIF proposal, expediting the receipt and handling of the funding for the PIF project has been a primary consideration. Proper safeguards have been included which assure funding is expended as scheduled, and proper notification is provided to the customer when expenditures reach an agreed-upon percentage of the total. The PIF organizational and operational structure goal has been to offer an acquisition-streamlined environment, which allows for rapid acquisition and obligation of customer and direct site funding. Schedule considerations and risk mitigation have been a primary focal point for successful project management. The PM Team Lead develops the initial milestones and executes to the approved schedule, as agreed to in the proposal/ROM and the initial kick-off meeting. The PIF then establishes realistic exit criteria for each PIF project phase, utilizing evaluation of performance against metrics, conduct of in-process reviews (IPRs), scrutiny of status reports and other project management tools to ascertain the cost, schedule, and performance attributes of each assigned PIF project.

For Aviation-related projects, a key product has been the Airworthiness Release (AWR). The PIF has addressed AWR throughout these efforts, through the early involvement of the AMCOM Aviation Engineering Directorate (AED), to assure smooth and rapid processing of the AWR paperwork. As deemed appropriate, the PIF has sought early involvement to expedite the Supplemental Type Certificate (STC) for those aircraft governed by Federal Aviation Administration (FAA) regulations. Upon completion of all necessary testing and qualification, products are then delivered to the customer. For aviation assets, airworthiness is normally addressed by one of the contractual

deliverables, as an AWR or STC. As previously negotiated with the customer, other deliverables have included performance or product specifications, tests/demonstrations, technical reports, prototype hardware or software, a complete Modification Work Order (MWO) kit suitable for production, or limited production of MWO Kits, validated Level I, II or III technical data packages (TDPs). Whatever the product, it has been the goal of the PIF that products be delivered on or ahead of schedule, at or below cost, and fully qualified and in congruence with the contract/SOW.

C. ORGANIZATIONAL STRUCTURE

Figure 5 depicts the PIF organizational structure (Reference 7.). This structure reflects the leveraging of several organizations, both Government and industry, that support the PIF business strategy.

1. PIF Core Organizational Structure

The top level of the PIF organizational structure reflects the PIF core organizational structure. The PIF core is comprised of Government personnel who maintain PIF operational control. Personnel at this level are Prototype Engineering Division and EAP Lab personnel who have been collocated and operate functionally as one organization. This level is subdivided based upon the various areas of responsibility that one would expect to see in a prototype environment. Each of these personnel's roles and responsibilities has been defined to support PIF objectives.

The PIF Manager reports directly to the Deputy Director, Engineering Directorate and provides strategic guidance to all PIF organizational elements. The PIF Manager has established strategic organizational goals and evaluated actual PIF performance in seeking to achieve these goals. The PIF Manager exercises full authority over all PIF projects, workload, assets, and funding, and is responsible for the planning, managing and execution of the PIF vision and mission

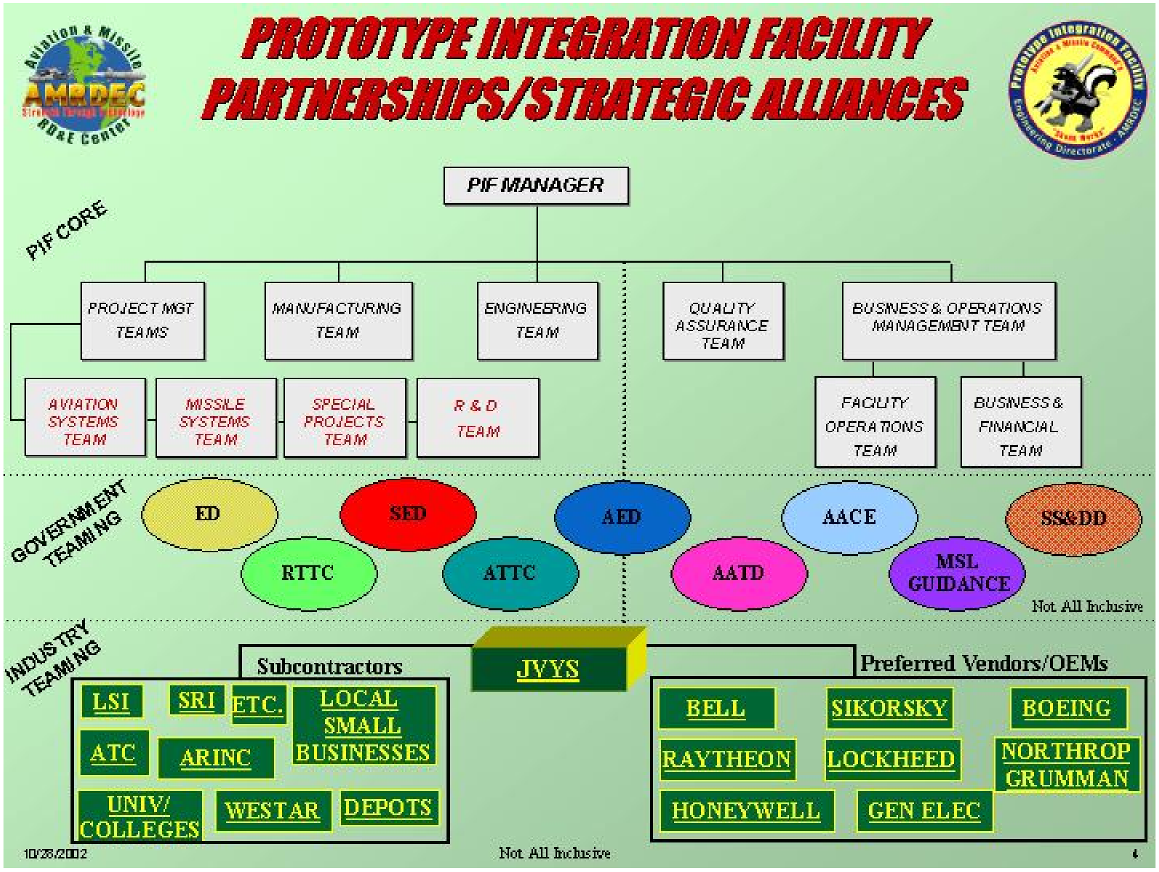

Figure 5. PIF Organizational Structure.

All PIF projects will be managed through a PIF Project Management Team Leader. The Project Management Team Leaders report directly to the PIF Manager and exercise complete responsibility and authority for coordinating, planning, staffing, directing, and controlling assigned PIF projects. The PIF project management functionality is segregated into four primary areas or four Project Management Teams; these are (1) Aviation Systems Team, (2) Missile Systems Team, (3) Research & Development (R&D) Team and (4) Special Projects Team. As the PIF mission and workload evolves, these areas are periodically reviewed to identify spikes in workload and customer base issues to insure that the availability of the correct mix of project management resources are allocated to support the PIF mission and meet customer needs.

The PIF Business and Operations Team is responsible for planning, scheduling, directing, coordinating, and controlling all PIF business, financial, programmatic, and facility operations activities. These activities include, but are not limited to, project

planning, budget formulation, project execution, project/workload evaluation, financial management, review and analysis, cost estimating, procurement, marketing, facilities operations, information technology, and management reporting functions. For ease of operations, the Business and Operations Team is segregated into two primary focal areas, the Facility Operations Team and the Business & Financial Management Team. The PIF Business and Operations Team Leader also reports to the PIF Manager.

The PIF Engineering Team Leader exercises complete responsibility and authority for the engineering/technical management of PIF projects. The PIF Engineering Team provides engineering inputs to PIF project planning, proposal, management, scheduling, and execution activities, and advises the PIF Manager in their area of engineering/technical management to facilitate the execution of organizational and management activities. The PIF Engineering Team also works hand-in-hand with PIF Project Management Team Leaders to allocate Engineering Team resources to support PIF projects. These activities include the identification of personnel, the development of proposals and quotations, workload management, and identification of proprietary data/sources.

The PIF Manufacturing Team Leader also reports directly to the PIF Manager and exercises complete responsibility and authority for all manufacturing functionality of PIF projects. The PIF Manufacturing Team provides technical support for manufacturing and manufacturing control processes, systems, and services relating primarily to prototyping/production processes, resources, and facilities. In addition, the PIF Manufacturing Team Leader coordinates and participates in the analysis, design, development, and maintenance of manufacturing business processes and systems, which primarily support the PIF manufacturing operations.

The PIF Quality Assurance Team Leader exercises complete responsibility and authority for administering the PIF quality assurance program. The PIF Quality Assurance Team provides quality inputs to PIF project planning, proposal, management, scheduling, and execution activities and advises the PIF Manager in their area of quality assurance to facilitate the execution of organizational and management activities. The PIF Quality Assurance Team also ensures that all business processes and all material

being developed, procured, manufactured, rebuilt, modified, integrated, or stored in PIF are in accordance with approved design requirements, specifications and guiding quality improvement principles. And lastly, the PIF Quality Assurance Team is responsible for establishing, administering, and maintaining the PIF quality assurance program for all PIF activities.

2. Governmental Organizational Partners

Establishing strategic relationships with other Government organizations, both AMCOM and non-AMCOM, has been critical to the success of the PIF. The second level of the PIF organizational structure reflects a cross-section of Governmental organizations that the PIF has teamed with. Under the PIF business strategy, as weapon system requirements are identified and resources sought to satisfy system requirements, the PIF has canvassed a variety of Government organizations for cost effective expertise. These include the vast technical capabilities within the AMRDEC, and include the Software Engineering Directorate, the Missile Guidance Directorate, the Aviation Engineering Directorate, the Propulsion and Structures Directorate, the Aviation Applied Technology Directorate, and the System Simulation and Development Directorate. Corpus Christi Army Depot and Letterkenny Army Depot, both of whom report to the AMCOM Commander, also have partnering relationships with the PIF. Other, non-AMCOM Governmental organizations partnered with the PIF include the Redstone Technical Test Center (RTTC), the Aviation Technical Test Center (ATTC), and the Logistics Support Facility. The PIF has initiated discussions with the NASA Marshall Space Flight Center and the Defense Advanced Projects Agency to develop partnering relationships that will also be of benefit to aviation and missile weapon system program managers.

3. Industry Organizational Partners

The PIF concept also required, and therefore included, a partnering relationship with industry, to include small businesses, small minority-owned businesses, OEMs, and other industry partners who offer the capability-specific expertise required to support the prototyping requirements of aviation and missile program managers. The bottom-level of the PIF organizational structure identifies PIF industry team member's to-date. The ten-year, $1.1 billion PIF Rapid Acquisition Prototype (RAP) contract, awarded to the Joint

Venture, Yulista, Science and Engineering Services, Inc. (JVYS), is the mechanism through which industry partners with the PIF.

The inclusion of the OEMs in the PIF organizational structure, while seemingly odd, was an absolute necessity when crafting the strategy. While there have been limited instances where the PIF was able to successfully compete with OEMs to secure tasks, it was not the stated intent of the PIF to do so. The inclusion of the OEMs into the PIF structure was deemed a critical element in providing program managers with the cost effective prototyping support that they required. Many contractor-operated prototyping operations seek to solely compete with the OEM as an alternative to meeting program manager requirements. The PIF concept was developed to include OEM capabilities, such as engineering and technical data support, due to the necessity to access these and other OEM capabilities, to support the requirements of program managers.

The addition of other capability-specific industry members was also one of the key facets to the PIF partnering strategy. The companies that comprise this category are able to integrate their capabilities with those of the OEMs and the Government to provide an efficient and economical product to the program manager. Many of these industry partners have existing capabilities and facilities, some of which are Government-sponsored, that the PIF has been able to leverage in the course of doing business with aviation and weapon system program managers.

Small business and small, minority-owned businesses have been a key thrust in the development of the PIF strategy. The PIF business strategy has been to graduate itself from piece-part and component-level tasks, to larger, more platform oriented integration types of tasks. This business strategy has afforded the PIF the opportunity to develop and utilize small businesses and small, minority-owned businesses to provide the component-level capabilities, such as circuit boards and machined components, to support the PIF business strategy.

The fundamental strategy of the PIF has been to provide program managers with a cost effective alternative to acquire materiel. Accomplishment of this strategic objective required the integration of existing prototyping capabilities with other expertise, both internal and external to the Government, and both internal and external to AMCOM.

This unification laid the foundation that would allow the leveraging of a diverse, cost effective set of capabilities that could be accessed to provide a best value capability to the growing needs of weapon system program managers.

D. THE PIF RAPID ACQUISITION PROTOTYPING CONTRACT

From the outset, it was clear, that a unique, flexible contracting mechanism would be required to fulfill the increasingly demanding needs of aviation and missile program managers, and to take advantage of existing prototyping opportunities. The ten-year, $1.1 billion PIF Rapid Acquisition Prototyping (RAP) contract was awarded in June 2002 to support the PIF concept and to meet the needs of aviation and missile program managers.

The process to achieve award of the PIF RAP contract began in January 2001. A market survey was conducted through the assistance of the AMCOM Small Business Administration (SBA) and the use of PRO-NET, an internet-based program, as the need for a flexible contract mechanism was identified. An Indian tribe, Yulista Management Services Incorporated, was identified as a potential source and a capabilities briefing was presented to PIF Manager, PIF Team Leaders, and the PIF Contracting Officer's Representative (COR). On 19 March 2002, the Small Business Administration (SBA) approved the joint venture agreement between Yulista Management Services Inc. and Science & Engineering Services (SES) Inc. The PIF RAP contract, a sole-source Cost Plus Fixed-Fee (CPFF) contract, was awarded to the Joint Venture, Yulista, Science and Engineering Services, Inc (JVYS), an eligible Section 8(a) concern owned and controlled by an economically-disadvantaged Indian Tribe, as permitted by FAR 19.805-1 (b) (2). The JVYS, through this contract mechanism, serves as the PIF prime contractor. Although the JVYS concept employs partnerships with key industry subcontractors and preferred aviation and missile OEMs, the PIF maintains privity of contract with JVYS. It is the responsibility of JVYS to execute and manage all subcontractor and/or preferred OEM contractual vehicles.

It is the sole responsibility of the PIF Project Management Team Leader to ascertain internal and external resources required to meet specific project requirements. Once a determination has been made that PIF internal resources are not adequate to meet a customer's need, the PIF Project Management Team provides the JVYS with a

proposed technical Directive Execution Plan (TDEP) SOW for the effort required. Any tasking or technical directive is required to be within the scope of the overarching PIF RAP SOW. The PIF Project Management Team Leader is the primary point of contact for interface and coordination of issues or questions concerning JVYS proposal development. The JVYS is responsible for developing a TDEP that is clear, concise, and that specifically addresses the requirements down to the project-level SOW/technical directive. The JVYS TDEP, at a minimum, addresses the requirements of the TDEP SOW or technical directive, subcontractor teaming arrangements, proposed facilities/equipment, and those work elements to be performed by each of the principal parties, as well as cost, schedule, and performance attributes. Additionally, the cost and schedule proposal assigns performance metrics for each principal party involved in the project.

The PIF RAP contract has been structured to provide maximum utility to program managers. A twenty-one day turn-around-time has been set to exercise options or task directives once requirements have been initiated. This element of the PIF RAP contract allows program managers the opportunity to reduce the cycle time normally associated with traditional procurement processes. In addition, the program manager reduces funding risk through the expeditious obligation and disbursement of funds when utilizing this contract vehicle. The PIF RAP contract, advantageous due to its quick turn-around features, also provides added benefits when utilized. Negotiated composite labor rates for contractor personnel are extremely low, as are the low G&A fees for the JVYS and subcontractors. Material costs are not passed through the JVYS, which further reduces the cost to the program manager.

E. FACILITIES

In order for the PIF concept to properly evolve, a facility would be needed, not just to centralize the geographically-dispersed prototyping capabilities that existed at AMCOM, but more importantly, to facilitate the integration of all of the capabilities required to support the developing PIF business strategy.

The pre-PIF prototyping facilities were located throughout Redstone Arsenal. Building 4762, which housed the mechanical prototyping capability, was a 1940's vintage building comprised of 32,000 square feet. This building was located five miles

from the AMRDEC main facility, Building 5400, and was in dire need of costly repairs. Replacement of the heating, ventilation, and air conditioning system and replacement of the collapsing ceiling was estimated to require in excess of $1 million. The EAP Lab consisted of approximately 5,000 square feet of floor space and was scattered throughout Building 5400. These accommodations were not suitable, either functionally or geographically, to support the basic prototyping needs of aviation and missile weapon system program managers.

In 2000, the Engineering Directorate was presented with the opportunity to secure the funding for the design and construction of a facility, whose primary focus was on the prototyping of weapon system hardware. After several months of discussions with Redstone Arsenal Support Activity and Corps of Engineers personnel, $9.9 million in funding was acquired to design build a 60,000 square foot Prototype Integration Facility. Figure 6 shows the Larry O. Daniel Prototype Integration Facility. This facility includes a 173ft by 75 ft high-bay area with two 20-ton overhead cranes, a 10,000 square foot low-bay integration area, a 102,600 square foot exterior hardstand area capable of withstanding 3000 p.s.i., and a helicopter landing-pad meeting FAA specifications.

Figure 6. The Larry O. Daniel Prototype Integration Facility.

These capabilities/facilities permit on-site integration of hardware and software directly into a variety of aerial and ground platforms, including helicopters, Unmanned Aerial Vehicles (UAVs), Highly Mobile Multi-purpose Wheeled Vehicles (HMMWVs), 5-ton trucks, and tanks. Figure 7 portrays a portion of the PIF high-bay as PATRIOT Battery

Command Post Vehicles are assembled. The PIF high-bay allows for flexible reconfiguration to support a wide range of aviation and missile hardware.

Figure 7. PIF High Bay.

The PIF low-bay integration area, shown in Figure 8, provides precision fabrication capabilities in machining, sheet metal, welding, and painting. The low-bay also incorporates a mechanical department and state-of-the-art equipment that can produce various types of fabrication solutions and offers a wide capability for hardware manufacturing. Mechanical manufacturing capabilities include all types of general and precision metal machining, sheet metal fabrication/work, welding, assembly, and finishing/painting. In-house capabilities in the areas of specialized coatings including Chemical Agent Resistant Coating (CARC), plating, heat-treating, and other specialized processes also exist in this area.

Figure 8. PIF Low Bay Integration Area.

Figure 9 shows a UH-60 Blackhawk making use of the PIF landing pad. The PIF landing pad capability allows for the timely modification of all aviation systems.

The Larry O. Daniel Prototype Integration Facility was dedicated in July 2002, and serves as the centerpiece of the PIF concept. The PIF was named for Dr. Larry O. Daniel, the former Director of the Engineering Directorate, who was the driving visionary behind the PIF concept. This facility has provided the infrastructure that has allowed the PIF concept to flourish, and Dr. Daniel’s vision to be achieved.

The PIF concept, while utilizing the Larry O. Daniel PIF as a centerpiece, is not solely dependent on this facility to accomplish PIF tasks. The PIF, through its strategic partnering relationships with other Governmental and industrial organizations, has the ability to utilize associated facilities as necessary. The use of the RTTC, Software Engineering Directorate, and JVYS facilities has already occurred in the performance of aviation and missile prototype efforts.

Figure 9. PIF Landing Pad.

F. PIF CAPABILITIES

The PIF concept is built on the ability to leverage the capabilities necessary to meet the needs of aviation and missile program managers. Many of the capabilities utilized in the performance of efforts to support these needs exist within the PIF. The PIF provides a menu of the internal capabilities available to aviation and missile weapon system program managers. This menu comprises any level or complexity of capability that a program manager may need to satisfy a requirement.

The PIF includes an extensive circuit card design and layout laboratory. Engineering schematics and component specifications are developed and transferred into producible circuit board designs, which are fabricated at the PIF, tested, and loaded with the requisite components required for integration or evaluation purposes. The circuit board laboratory utilizes powerful computer-aided design (CAD) and computer-aided manufacturing (CAM) tools combined with an experienced staff to complete such layouts as radio frequency (RF) boards, Ball Grid Array Technology (BGA), high-speed

electronics, and high-power requirements. The PIF also incorporates the industry leading Cadence Spectra auto-router for faster completion of dense layouts. The Soldering Laboratory utilizes soldering processes that are in accordance with industry standards, including Soldering Workmanship Criteria IPC/EIA J-STD-001 Class 3, and Electro Static Discharge Controls in accordance with ANSI/ESD S20.20. Soldering experience includes the fabrication of hardware from very simple to the most complex configurations. Process control methodology is relied upon to ensure consistent quality levels during the manufacture of products. Areas defined and controlled include materials, methods, and acceptance criteria for producing satisfactory solder connections. Capabilities include soldering and repair of older designs, prototype designs, and new designs that incorporate through-hole and/or surface-mount technology.

The Electronic, Simulation, and Analysis Modeling (ESAM) capability provides a risk reduction tool to program managers through the utilization of circuit analysis software to perform simulation, analysis, and modeling of electronic circuits. The ESAM team is able to provide technical, cost, and schedule risk reduction to customers by modeling and analyzing electronics circuits for safety, reliability, and performance. Safety issues with electronics designs, including those that involve ordnance-firing devices, are addressed through the ESAM capability. The ability to perform sneak-circuit analysis to identify potential sneak electrical paths is also part of this capability. The ESAM team is able to improve system reliability by identifying electrically-overstressed components and recommend design solutions for marginal designs. When failures do occur, the ESAM team is able to determine the root cause and develop and validate design solutions. The ability to model missile flight control electronics, including electrical and thermal batteries, to evaluate and validate system performance is a key component of the ESAM capability.

The PIF provides proactive obsolescence management, early in the life cycle of a weapon or aviation system as a critical tool for maintaining operational readiness for complex aviation and missile weapon systems. The accelerating pace of electronic advances, Commercial-off-the-Shelf/Non-developmental Item (COTS/NDI) insertion, extension of weapon system life cycles, and emerging aging aircraft issues is presenting new obsolescence management challenges to Army program managers. Addressing the

increasing complexity of obsolescence management, the PIF has an established program utilizing processes and procedures in accordance with DoD policy for identifying and resolving obsolescence issues. Prototype Integration Facility obsolescence management capabilities include acquisition contract scope of work preparation, proposal evaluation/negotiations, comprehensive obsolescence management risk assessments, program parts selection, component availability projections, projected obsolescence resolution of sustainment costs for out-year budgeting, redesign and testing of obsolete hardware, obsolescence notice alert monitoring and notification, and Continuous Technology Refreshment (CTR) analysis.

The Visualization-Based Design Laboratory (VIZ Lab) designs, develops, and produces advanced 3-D solid, data, and virtual models for weapon system engineering, logistics, and program management disciplines. The VIZ Lab's robust structure allows it to align and progress as the modeling industry develops new technologies and techniques on the road to fostering an overall collaborative engineering environment. The VIZ Lab can expand into newly-emerging areas and implement innovative capabilities that track with state-of-the-industry tools and products. The VIZ Lab provides the aviation and missile community with the capability to create 3-D engineering models for visualization, simulation, and virtual prototyping of designs used in customized engineering analysis and logistical applications. Engineering modeling functions within the VIZ Lab include reverse engineering, 3-D CAD model generation, comprehensive weapon system models, component and assembly models, and low-fidelity/artistic renderings. Models developed within the VIZ Lab are used in applications for CAD design; engineering analysis; operation, setup and maintenance manuals; interactive multimedia instruction; training; engineering animations of collision and interference detection; and engineering kinematics and dynamic analysis.

The PIF also provides a rapid, state-of-the-art virtual prototyping capability, which allows verification and optimization of designs quickly and accurately, resulting in time and cost savings when compared to traditional prototyping methods. Utilizing state-of-the-art technologies, parts can be quickly and economically fabricated in various materials, such as plastic, wax, epoxy, laminated paper, polycarbonate, solid starch and various types of metals, depending on intended use. Whether a customer needs to access

to interfaces and ergonomics, or just needs a physical demonstration piece to articulate a concept, the PIF can quickly turn drawing/engineering files into reality. During the design phase, the PIF's rapid, virtual prototyping technologies provide a streamlined verification system for hardware concepts, as well as checkpoints later in the process. Rapid, virtual prototyping capabilities include Stereo Lithography, Fuse Deposition Modeling, Laminated Object Manufacturing, Selective Laser Sintering, Three-Dimensional Printing, Multi-Jet Modeling, and Laser Engineered Net Shaping (LENS).

G. RESULTS

The initial indications are that the PIF concept, after only eight months in full implementation, has been very popular among program managers, especially among those in the aviation area. Figure 10 depicts a snapshot of the PIF business environment as it exists today (Reference 8.). This chart shows the spike in PIF business after the opening of the PIF and the subsequent award of the PIF RAP contract. To date, $18 million of new business has been generated since June 2002. Fiscal Year 02 sales are projected at approximately $32 million, with opportunities to significantly increase this amount through the execution of several efforts that remain in the proposal/negotiation cycle or have just been initiated. The $18 million of new business is the result of the PIF securing several new efforts. These include the Blue Force Tracking, Enhancement Information System, the Mobile Tower System, the Tactical Terminal Control System, the Common Transponder, and the Blackhawk Global Positioning System.

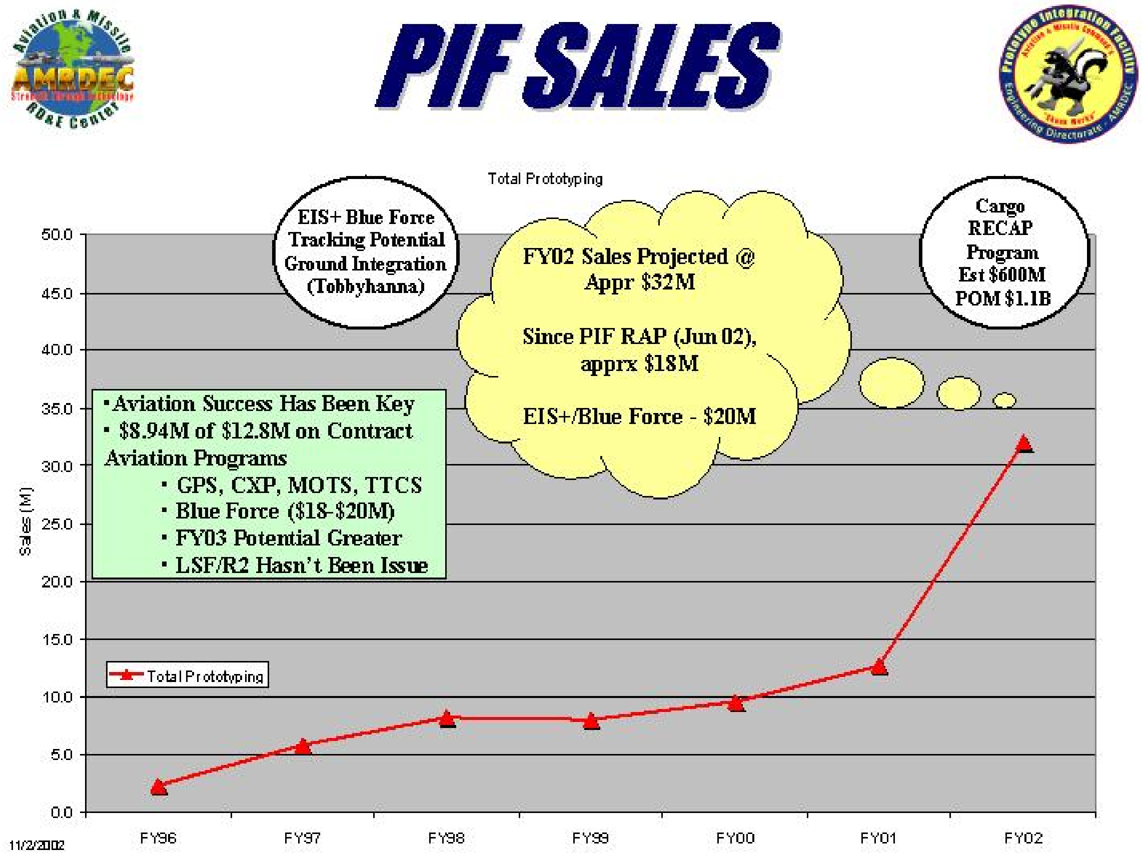

Figure 10. PIF Sales.

The Blue Force Tracking, Enhancement Information System effort is a quick-turnaround, $20 million program that will upgrade information systems to allow for the tracking of friendly forces in forward areas.

Figure 11 provides a depiction of the Blue Force Tracking, Enhancement Information System functional architecture. The Blue Force Tracking, Enhancement Information System will provide the aviation fleet the ability to transmit and receive situational awareness and command and control information between air and ground platforms, the ability to display air and ground locations for all friendly forces on an electronic map in the host platform display, and provision for exchange of email text between platforms.

This task was initiated in FY 02 and will be completed by FY 03. The PIF is teamed with the Aviation Applied Technology Directorate and will fabricate and install 96 Phase 3 and 4 systems on AH-64s, UH-60s, and CH-47s by 1 December 2002, 160

Phase 5 systems on AH-64s, UH-60s, CH-47s, and OH-58s during CY03, and upgrade all OCONUS aircraft during Phase 6.

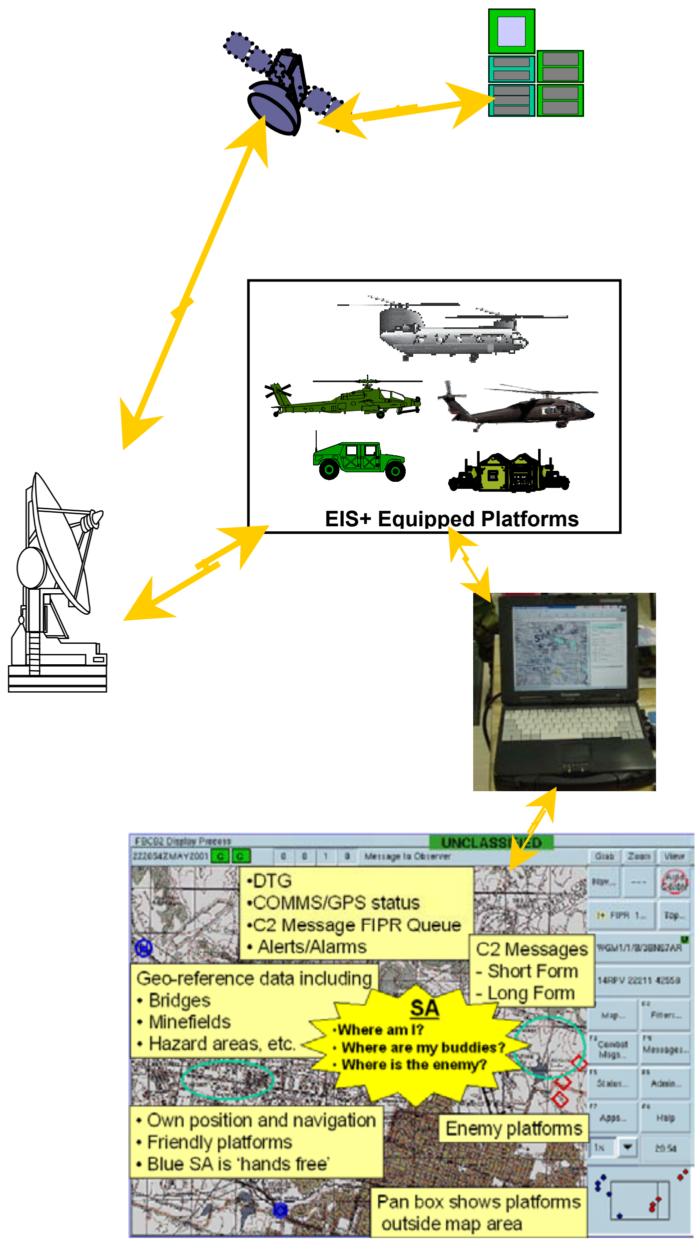

Figure 11. Blue Force Tracking, Enhancement Information System.

The Mobile Tower System (MOTS) is a six-year $36 million program that will provide the Army a with a quick, deployable, highly-mobile air traffic control tower to be used at remote airfields. Figure 12 provides an illustration of the MOTS. The PIF is teamed with the RTTC and has initiated the first phase of this effort, which is to build one

prototype MOTS, integrate Airborne Radio Communications (ARC) 220 and Platoon Radio Communications (PRC) 117's into the tower, integrate 10 Kilowatt generators on trailers, coordinate electromagnetic interference (EMI), electromagnetic compatibility (EMC) and road testing and develop a drawing package. At the end of phase one, the MOTS will be fully developed and qualified.

Figure 12. Mobile Tower System.

The PIF also succeeded in landing the Tactical Terminal Control System (TTCS) task. The TTCS is a highly-mobile air traffic facility, which is used at the Brigade-level to provide Air Traffic Services (ATS) at remote landing zones, drop-zones, and temporary helicopter operating areas. It is capable of ground-to-air communications between Army, other Services, and allied aircraft. It is also capable of ground-to-ground communications internal to ATS units and ATS units and other ground units. The configuration allows some of the components of the TTCS to conform to man-pack configurations. Figure 13 shows the TTCS. Figure 14 depicts the TTCS communication suites. The PIF TTCS task is a $1.2 million effort that will integrate ARC-220 radios and KY 100 and Fanlight antennas into the TTCS. Radio menus and control software will be upgraded and an updated technical data package and technical manual will be provided. Three prototype systems will be installed and tested as a part of this task.

Figure 13. Tactical Terminal Control System.

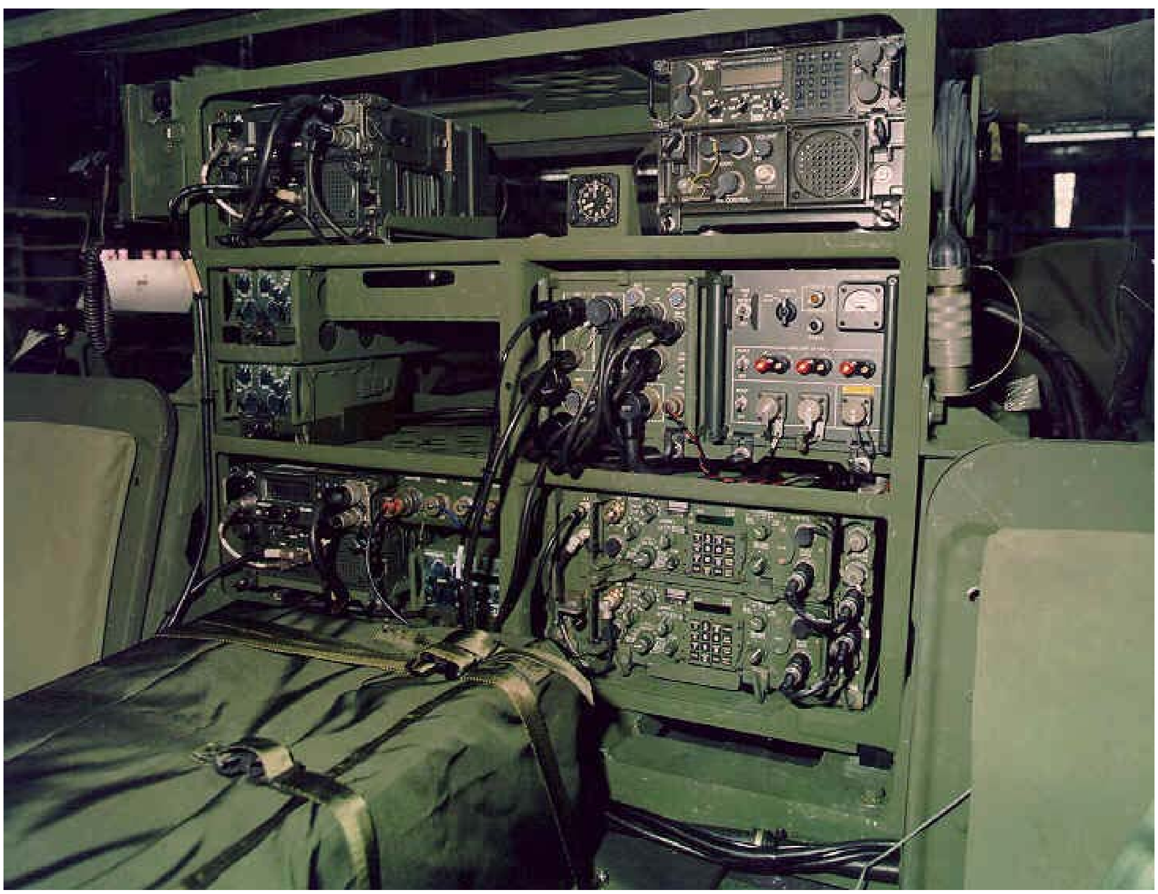

Figure 14. Tactical Terminal Control System Communications Suite.

The PIF has also succeeded in acquiring the Common Transponder Program (CXP). The CXP replaces the AXP-100, currently in the OH-58, with the upgraded AXP-118. The PIF is teamed with the JVYS, Lear Siglear, RTTC, and ATTC, in this one-year, $1.1 million program, to develop, prototype, validate, and verify the OH-58 Control Display System Version 4 (CDS4) programs.

The PIF is also performing embedded global positioning system, inertial navigation system (EGI) integration into the UH-60 and CH-47 aircraft. The H-764G EGI program is a tri-service; United States Air Force-led effort to provide an integrated navigation solution for aircraft equipped with a MIL-STD 1553 digital data bus. The EGI embeds a 5-channel GPS receiver into a ring laser gyro inertial navigation system, making the total system weight only 17.9 pounds. The EGI will provide extremely precise location to the aircraft fire control computer or integrated system processor for processing targeting information/sensor pre-pointing. The EGI is the objective, fully-digitized GPS solution for scout/attack helicopters. Figure 15 shows the H-764G EGI System. The PIF is teamed with the JVYS, RTTC, ATTC, and ARINC on this $2.025 million effort.

While the PIF has succeeded in taking advantage of new opportunities to prototype aviation hardware, it has continued to support on-going programs, including the PATRIOT Battery Command Post (BCP) program. The PATRIOT BCP is a replacement for the two and one-half ton M109 Van. The design, fabrication, integration, and testing of Phase 1 prototypes is complete. A total of 24 Phase 1 BCP’s will be integrated, with 14 already deployed. Phase 1 development was initiated in FY03, with a requirement to integrate 41 BCPs. Figure 16 depicts the PATIOT BCP.

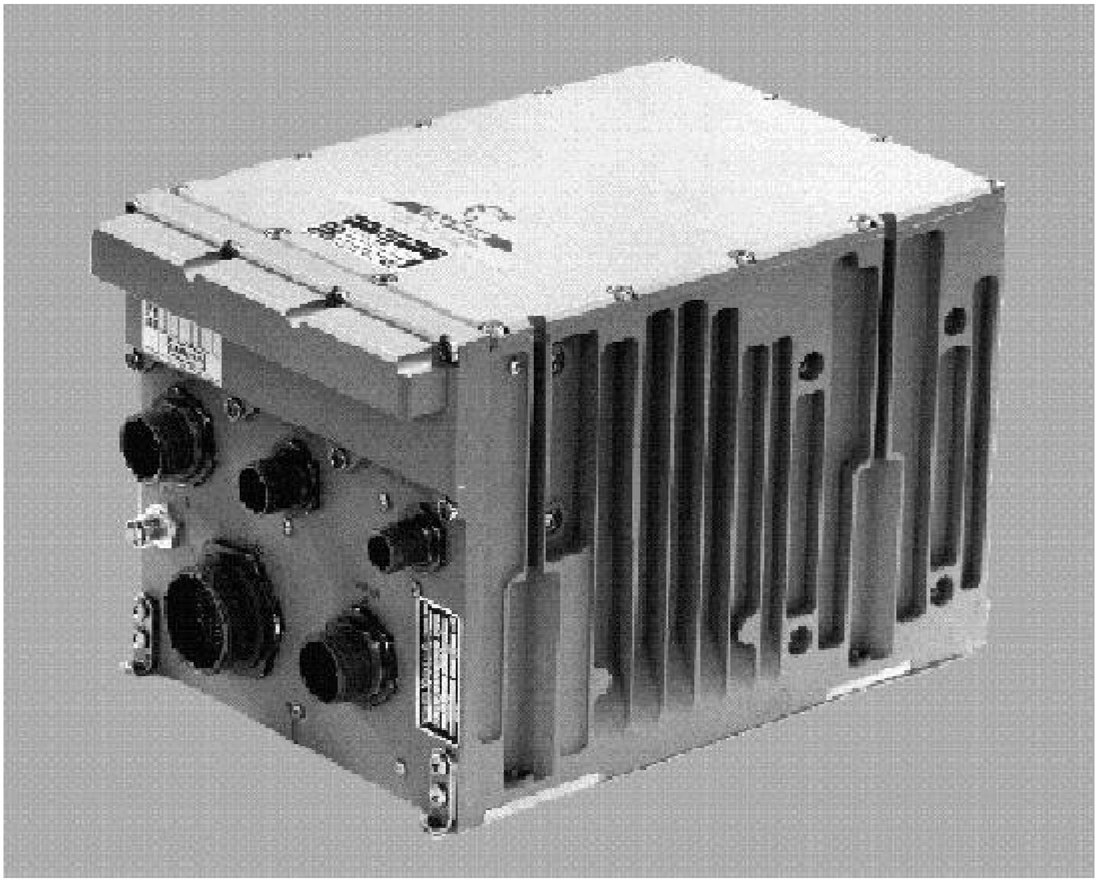

Figure 15. The H-764G EGI System.

Figure 16. PATRIOT Battery Command Post.

While the PIF concept has been successful in taking advantage of new opportunities, as evidenced by the rapid increase in aviation weapon system business, it has also embarked upon a path to provide program managers solutions to satisfy other, non-modification, types of requirements. As an example, the PIF has submitted a proposal to the CH-47 program office to reduce recapitalization costs of the CH-47 fleet. The PIF proposal has identified fifty-one of the sixty-one recapped components as low-risk candidates that lend themselves to 'breakout' procurement. The PIF would manage the acquisition of these components, while utilizing the OEM for procurement of the other ten items. Utilizing the PIF-proposed methodology would significantly reduce the engineering support costs proposed by the OEM. Through the incorporation of a best-value type of approach, the CH-47 program would achieve a twenty –five to forty percent reduction in overall recapitalization costs. The OEM would still be utilized for management of ten of the sixty-one recapped items, as well as for engineering and data support for the fifty-one 'breakout' items.

The PIF concept also presents program managers with the opportunity to prove out technology developments that may be critical to the affordability of their systems. For instance, the Comanche program manager is utilizing the PIF to manage the development of a composite transmission housing. The composite transmission development effort is a key program component, aimed at reducing the overall weight of the Comanche system. Through the PIF concept, the Comanche program manager is afforded the benefit of leveraging the efforts of several organizations, including the AMRDEC Engineering and Aviation Engineering Directorates, Comanche program office, and Sikorsky, to have them collectively-focused, and locally-managed to insure program office goals are achieved.

H. CHALLENGES

Many challenges were faced while crafting the PIF concept. The most prominent was overcoming the cultural barriers that existed in all of the facets of the concept. This has required an intense level of oversight by Engineering Directorate management personnel to insure that the necessary actions were taken to enable the PIF concept to emerge.

The most significant challenge involved the articulation of the PIF concept, its power, and its potential. This proved to be very difficult, in that the new PIF concept was very innovative and creative in comparison to what had previously existed. The uniqueness of the concept made it difficult to understand, much less accept. The PIF concept required those involved to extend themselves beyond the level of comfort that they had enjoyed in their present positions and organizations. The PIF concept was developed from a business perspective, which was the mutually-beneficial ability to resolve program manager's increased prototyping needs, and to perform that work on a customer-reimbursable basis within the AMRDEC. This also required that the way business was currently being done would be dramatically changed. Under this concept, the PIF would have to operate more like a business and less like a Government organization. This was not, and is still not, universally understood by most within the AMCOM community.

One of the early challenges involved merging Prototype Engineering Division and EAP Lab personnel physically and functionally into one new fully-integrated organization. These personnel were some of the first to be exposed to the new concept, and among the first who would be required to accept changes in their roles and responsibilities. Since most of these personnel had established roles in their respective organizations, this was a particularly difficult change to accept. In addition, the physical movement of these two groups of personnel highlighted the distinctly differing cultures that had existed prior to the merger. Prototype Engineering Division personnel were accustomed to a more relaxed environment, where business growth was naturally achieved through repeat business from existing customers or word-of-mouth. Very little thought had been put into developing a business strategy that either took advantage of new opportunities or developed innovative capabilities. The EAP Lab personnel, on the other hand, had existed in a culture where business growth was encouraged and expected. New business development was included in EAP Lab personnel performance objectives. The ability of EAP Lab personnel to develop new business was, therefore, a key component of their annual performance rating. These vastly differing cultures created an initial environment of distrust and uncertainty, especially as personnel from both organizations clamored for positions in the new functionally-integrated organization.

The development of the initial functional operating organizational structure was left to senior personnel from the two organizations as an attempt to achieve some level of buy-in from the personnel who would be most affected. This process, however, became lengthy and emotions ran high on both sides, which ultimately inhibited the integration process. The resulting functional structure, while logically-based, has not achieved the level of acceptance needed to reach efficiency in operation, and has not been utilized as intended. One positive event that eased a portion of the tension between the two groups of personnel, was the dedication of the Larry O. Daniel PIF in July 2002. This was an extremely significant event, both in terms of the magnitude of the effort required and the level of the dignitaries that attended. All involved personnel worked extremely hard and were collectively responsible for the success of the dedication and the image presented to the key dignitaries that included, the Secretary of the Army, the Commanding General, AMC, and one Senator from the state of Alabama. The AMCOM Commanding General, on two separate occasions, recognized each person involved in this ceremony. This action, more than any other, has validated for many of the personnel involved, the magnitude of the opportunity presented by the PIF concept, and has served to partially mitigate the feelings of distrust remaining between the two groups of personnel.

The PIF concept proved difficult to communicate to industry as well. Since the ability of the PIF to partner with many levels of industry was a key component of the PIF concept, much effort was expended in this area. The ability to achieve approval from industry depended upon the ability of PIF management personnel make the mutually-beneficial business case. This was accomplished through efforts on two fronts. The first involved the acceptance of the PIF concept by the weapon system program manager community. Once the program managers were convinced that the concept would provide an affordable alternative for them to acquire materiel, industry became attentive and willing to discuss the details of the PIF concept. There existed, however, a certain level of reluctance, even at this point, due to the proposed industrial structure. The proposed structure utilized a joint venture of Yulista Management Services Inc. and Science & Engineering Services (SES) Inc. (JVYS) as the prime contractor, and proposed that other industry partners including OEM's, capability-specific companies, and applicable small businesses, function as subcontractors to the JVYS. While this structure was met with

some skepticism, it proved not to be a major barrier, but nonetheless, required a significant effort from PIF management personnel to resolve. The biggest hurdle was that associated with the teaming aspect of the structure. Culturally, the partnering concept was foreign to most of the required participants, including many of the OEM's and capability-specific companies. The small business community was actually better versed in this strategy and was much quicker to accept the structure. Two key aspects of the PIF concept helped to mitigate the concerns of the larger companies. The first was that the OEM's became convinced that the PIF was not structured to compete, per se, with their major business interests. While there might be instances where the PIF would compete for certain program manager requirements, in most cases OEM strategic plans did not involve the type of the work to be performed by the PIF. In fact, many of the OEM's frankly pointed out that they were not even interested in many of the types of tasks that the PIF was seeking, to the point, where they were even becoming a detriment to meeting program manager needs because of conflicting company priorities. The second aspect of the PIF concept, that garnered the attention of the larger companies, was the magnitude of the contract that was being put into place. When industry became aware that a ten-year, $1.1 billion contract was imminent, much of the initial reluctance surrounding the partnering structure evaporated. Industry was quite aware of the business opportunities that existed and the likelihood that they could compete for a significant share of that business.

The development of the PIF RAP contract was also a tremendous challenge that posed momentous barriers and required extraordinary measures to overcome. From the outset, it was recognized that the PIF contract mechanism would be an essential part of the PIF concept. Personnel from the PIF, along with AMCOM working-level acquisition center and legal personnel, analyzed the PIF vision and its requirements and crafted a contract mechanism to fit the requirement. The result was a unique contracting mechanism that enabled partnering with all levels of industry, and did so at reduced overhead rates and creative material dollar allocations. Because of the unique features and sheer size and length of the contract, this ten-year, $1.1 billion contract was subjected to an extraordinary level of scrutiny from the acquisition community. The bottom-line issue centered on their lack of understanding of the PIF concept, which led to this

scrutiny, that was eventually overcome after many discussions and meetings with acquisition center personnel.

Several key challenges remain that must be overcome in order for the PIF concept to be effectively and efficiently implemented. The foremost is the cultural challenge that continues to provide barriers to effective execution. These cultural challenges are evident in many areas, including both the personnel and organizational areas. The most notable cultural challenge, however, still evolves around a Government-owned, Government-operated facility partnering with industry and other Government organizations in a business-type of environment. The conservative nature of many of the functional support organizations at AMCOM will continue to present challenges to the PIF concept.

One other significant challenge exists for the PIF concept. That challenge involves the integration of the PIF concept into the newly-formed AMC, Research, Development, and Engineering (RDE) Command. The AMC RDE Command was formed to fully exploit the enormous potential that resides in research activities around the world. This new RDE Command was formed to respond by rapidly integrating, maturing, and demonstrating all emerging technologies to field the right equipment, in the shortest time, for our soldiers. The proposed RDE Command -organization is shown at Figure 17 (Reference 9.)

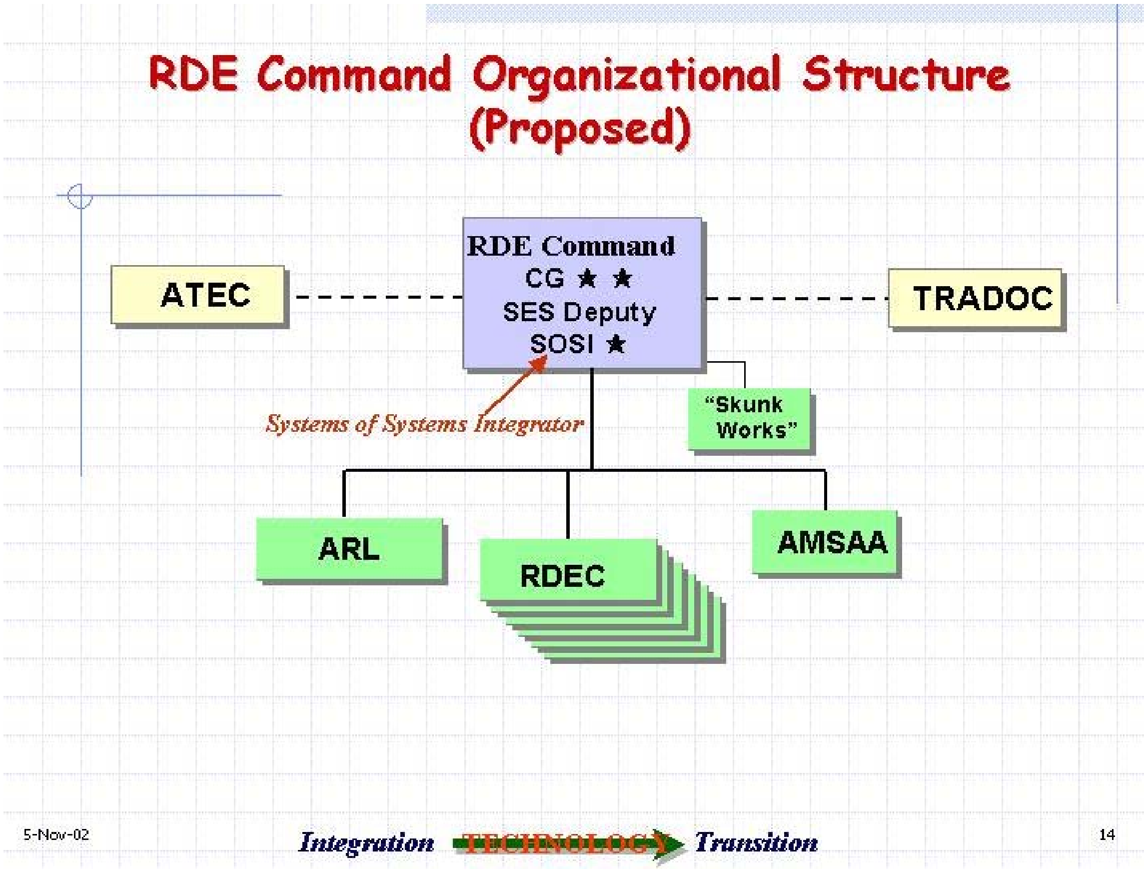

Figure 17. Research, Development and Engineering Command (Proposed).

The mission of RDE Command is to field technologies which will sustain America's Army as the premier land force in the world, and to be recognized as the preeminent world leader in research, development, and engineering of systems-of-systems whose hallmark is transitioning the right technology in the shortest time to our soldiers. The RDE Command has three primary objectives; to integrate Research, Development, and Engineering across all areas of the Army, the other Services, universities, and all other sources; to get the products of technology to the soldier faster; and to demonstrate the agility to rapidly take advantage of opportunities no matter where they may arise. The RDE Command states that the achievement of these objectives will require new and innovative approaches to all aspects of the development of technology for the soldier, and that the Commander of the RDE Command is empowered to experiment and test new ideas and processes (Reference 9.). One of the key facets of the RDE Command is the "Skunkworks" or Agile Development Center. The PIF management has proposed to the RDE Command Commanding General, to utilize the

PIF model as the means for the development of this capability. Figure 18 depicts the proposed structure that was briefed to RDE Command personnel (Reference 10.).

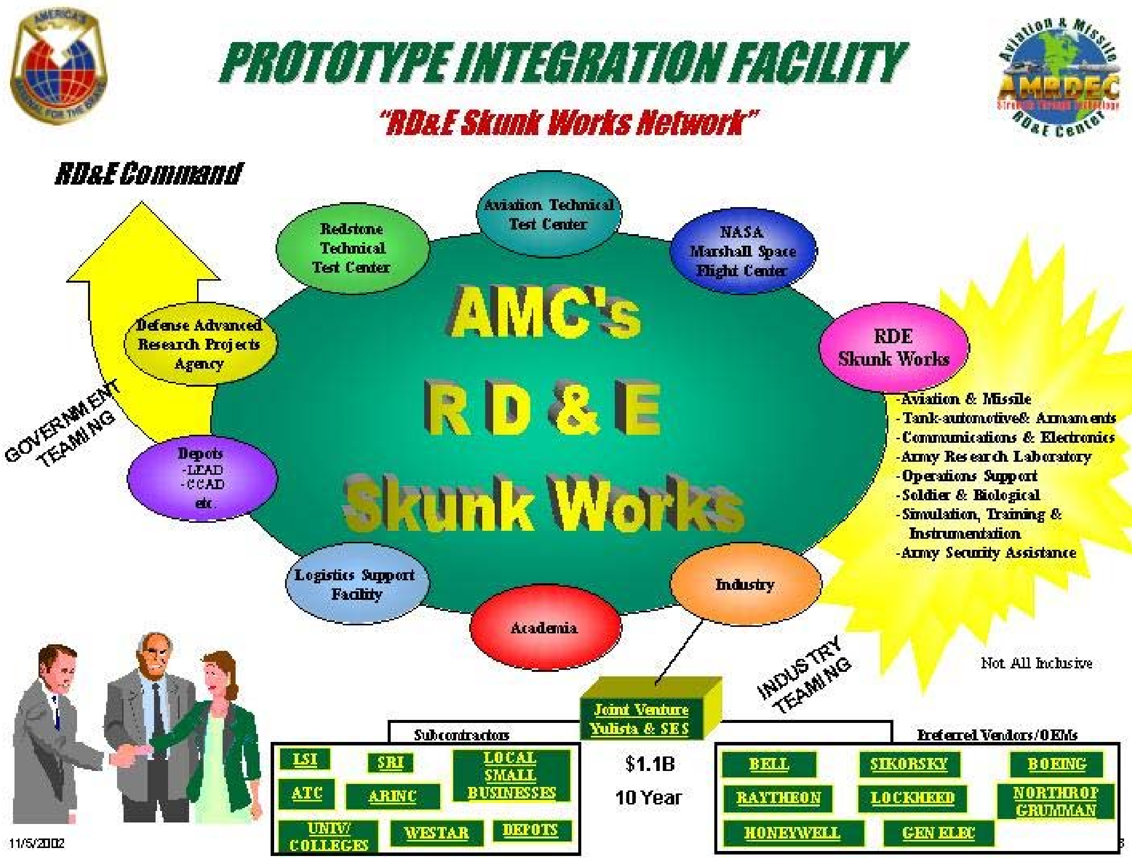

Figure 18. Proposed Research, Development, and Engineering Command Agile Development Organization.

Utilization of the PIF concept is the model of how the AMC RDE Command Agile Development Capability could leverage other Army prototyping capabilities and industrial resources and serve as the mechanism for the RDE Command to fulfill its objective to rapidly provide materiel to the soldiers in the field.

I. SUMMARY

The PIF concept is comprised of many facets, each of which plays an important role in its success. The interaction of the business strategy, organizational structure, facility, capabilities, and contract structure, laid upon the foundation of the internal prototyping experience that has existed at AMCOM for the last twenty-five years, has proven itself to be a worthy endeavor, valuable to both missile and aviation program managers. This is based upon the increased level of PIF business since the activation and

integration of these key elements. The PIF concept has the opportunity to play an even more significant role for the Army as future processes are considered to move Army-developed materiel into the hands of the warfighters in a more efficient manner.

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

This thesis has provided a case study of how a unique prototyping strategy was developed to support aviation and missile program managers. It has described the environment that existed at AMCOM, with both the prototyping community and the variables surrounding aviation and missile program managers with respect to their constant challenge to field materiel to the soldiers in a timely, cost effective manner. This thesis has provided a detailed analysis of the PIF concept, including the major elements that comprise this concept and the challenges that were overcome to implement it.

There are three major conclusions to draw from this case study. The first is to provide a constant awareness of the environment that exists, for both program managers and within supporting functional organizational capabilities, to be able to explore every opportunity to aid program managers by providing value-added capabilities to meet their needs and the needs of the warfighters. It is no secret that the global environment has changed dramatically since the World Trade Center terrorist attacks. It is also evident that the DoD environment, from where wars are fought, to how we fight wars, to what we fight with, is undergoing unprecedented transformation as a result. The Army acquisition community must be cognizant that these changes will continue to provide opportunities to assist program managers. The key to taking advantage of these opportunities will be the ability of the Army acquisition community to challenge both the culture and the traditional ways of doing business that currently exist within the Army. If the unique challenges that face the program manager of today and tomorrow are to be resolved, they will require creative solutions. The PIF concept is but one example of how an existing capability was retooled to provide a needed capability to program managers who are faced with the pressures of providing materiel to the soldiers in the field as expeditiously as possible.

The second major conclusion that can be derived from this case study is that it is incumbent upon Government functional personnel in positions of authority, to look to

other entities, both Governmental and industrial, to leverage their capabilities as a means to provide cost effective products to program managers, and to strengthen the Army infrastructure. What this really means is that the Government must begin to operate more like a business, and less like the stove-piped bureaucracy that it has been. This will require functional Government managers to perform initial and ongoing strategic assessments of Governmental and industrial capabilities to assess those that can be integrated to form value-added services for program managers. The development of business processes and the identification of resources, to include funding, personnel, and equipment, will then be required to support this integration effort. The program manager, and his needs, must also be considered as the key variable during this entire process in order for success to be achieved. The PIF concept is an example of how partnering and the utilization of various organizational capabilities can be of tremendous benefit to program managers. The mixture of Governmental and industrial capabilities that exist within the PIF concept, have given aviation and missile program managers an opportunity to cost effectively procure materiel. The internal and external expertise brought to the program manager through the PIF concept, is a key cost reduction variable that supports this model. And, the incorporation of the program manager into the development of the PIF concept, achieved the buy-in needed from the customer to validate the benefits of the concept.

Embarking on this kind of path, however, presents a significant challenge and requires an enormous amount of perseverance to achieve. Once again, leveraging and strategic partnering, force Government personnel, especially those in positions of authority, to think and act in a manner that challenges their "comfortable" mode of operation that had existed for many years. Breaking this cultural barrier is extremely difficult to achieve. Assuming this huge barrier can be overcome, the ability to then assimilate the resources and processed required to operate more like a business, present even greater challenges to the success of a concept of this nature. This requires effective communication both up and down the chain of command, to facilitate concept implementation. Because of the culture that exists within the Government, succeeding in an endeavor, such as the development of the PIF concept, is frequently stalled at higher

organizational levels. This often requires a great deal of political acumen and delicate maneuvering to overcome, which is no small task.

The third major conclusion is that the development of the PIF concept has proved to be initially successful, but requires significant attention to sustain the success it has experienced so far, and to achieve the requisite level of value to program managers. The influx of $18 million of new business to the PIF from March to October 2002, has validated the concept that was envisioned two years earlier, one that has taken advantage of the evolving environment and the challenges experienced by program managers. The AMRDEC has positioned itself to take advantage of these variables and has provided a much-needed service to program managers. The PIF, as successful as it has been initially, requires a significant level of continuing attention to insure the continuation of its success and to more effectively operate and compete for future business. Organizational, personnel, and facility challenges exist that must be proactively addressed in order for the PIF to sustain itself over the next ten-to-fifteen years. Replacing the "job shop" mentality that currently exists, with one of a business mentality, is a massive barrier that must be overcome in the next two years. Once a business mentality is achieved, it will then become necessary to identify, develop, and implement the business processes and tools necessary to allow for the sustainment and growth of the PIF.

B. RECOMMENDATIONS

The development of the PIF concept has been a unique and challenging task that has provided valuable learning opportunities for the future. The following are the primary recommendations resulting from this case study. These recommendations encompass those associated specifically with the PIF as it exists today, and those that relate to broader issues experienced during the development of the PIF concept.

1. PIF Organization

Engineering Directorate management should formalize the PIF organization. This will require that current personnel, belonging organizationally to the Prototype Engineering Division and the EAP Lab of the Manufacturing, Science, and Technology Division, be formed officially into one organizational structure, renamed the Prototype Integration Division (PID). The PID would consist of a GS-15-level division chief

reporting directly to the Deputy Director, Engineering Directorate. The PID would be structured to better facilitate the vision and objectives of the PIF, and would include both a technical and a business deputy, as a means to manage the significant growth in program manager business. The business deputy would provide the necessary attention to all business aspects of the PIF, which is a critical need for the success of the PIF to occur. Various GS-14-level team leader positions should also be established to acquire the necessary personnel expertise to support the PIF. This too, is a critical need that exists, and one that must be resolved before the PIF can more efficiently operate. All of these actions will require both significant interaction with the Civilian Personnel Activity Center (CPAC) and union approval to be successfully implemented. Once accomplished, PID personnel should embark on a series of team-building exercises to facilitate the elimination of previously-existing cultural barriers.

2. PIF Business Process Development

Engineering Directorate management, in conjunction with PIF personnel, should develop the business processes necessary to evolve the business infrastructure that is required for the PIF to sustain its growth potential. The development of an integrated data environment (IDE) is the most immediate tool that needs to be developed. Integrated data environment is a collaborative infrastructure embodying data standards that support business processes across geographically-dispersed locations and heterogeneous organizations. The IDE should be supported by an information infrastructure consisting of the hardware, software, and communications network resources required to store and transfer the data. In addition to information sharing, an IDE should allow for better configuration management and work process control. An Earned Value Management System (EVMS) should also be included as a part of the IDE tool development process. The development of an IDE tool is crucial to the future success of the PIF.

3. Establishment of a PIF Board of Directors

Engineering Directorate management and PIF personnel should establish a PIF board of directors (BOD) comprised of the Deputy PEO Tactical Missiles, Deputy PEO Air and Missile Defense, Deputy PEO Aviation, Associate Director for Aviation and Missile Systems, AMRDEC, and Director, Engineering Directorate. The primary

purpose of the PIF BOD would be to insure that the PIF is operating in such a manner as to provide effective and efficient support to program managers. The PIF BOD would also act as an enabler for the PIF to achieve developed strategic goals.

4. AMC RDE Command Agile Development Capability

Engineering Directorate management and PIF personnel should develop a strategic plan for PIF involvement in the development of the AMC RDE Command Agile Development capability. This plan, as a minimum, should propose Engineering Directorate management involvement in the development of this AMC RDE Command capability. It also should suggest the use of the PIF concept as a model for how this AMC RDE Command Agile Development capability should be developed.

C. RESEARCH QUESTIONS

1. Primary Research Question

- What are the primary tenants of the unique prototyping strategy developed at AMCOM and what benefits will it provide to aviation and missile weapon systems?

2. Subsidiary Research Questions

- What business and capability impacts does the AMRDEC prototyping strategy have on the AMRDEC as a whole?

Implementation of the PIF concept will have significant business and capability impacts on the AMRDEC as a whole. The PIF concept requires the use of the most cost effective expertise available, from both industrial and/or Governmental organizations. One of the key thrusts of the PIF concept is to use, to the extent possible, capabilities that exist within the AMRDEC. The AMRDEC is comprised of both an aviation and missile technical expertise, much of which does not otherwise exist. In addition, the use of AMRDEC expertise is often incurred at a reduced cost, given that the PIF is only charged for that specific portion of the time that an AMRDEC technical expert is utilized for a specific task. The PIF concept also has the potential to eliminate duplicative capabilities. Several organizations exist within the AMRDEC that possess limited prototyping and machining capabilities that duplicate those that already exist in the PIF. Likewise, many other AMRDEC organizations, through contractual means, have the capability to access other technical areas of expertise that are organic to the AMRDEC. The PIF concept would eliminate a large portion of the duplication that currently exists. The initial

implementation of the PIF concept has already seen the integration of capabilities from several AMRDEC organizations to support PIF tasks. The Software Engineering Directorate, Missile Guidance Directorate, System Simulation and Analysis Directorate, Aviation Applied Technology Directorate, and the Aviation Engineering Directorate have all provided technical expertise to support aviation and missile prototyping tasks. The PIF, through the continued institutionalization of this thrust, will strengthen the AMRDEC from both a capability and business perspective.

- What impact does the AMRDEC prototyping strategy have on other AMCOM and AMCOM tenant organizations?

The PIF concept also has the potential to have an extensive positive impact on other AMCOM and AMCOM tenant organizations. Through the PIF conceptual strategy to include cost effective expertise to support PIF tasks, other AMCOM and AMCOM tenant organizations have the opportunity to provide their expertise. The PIF already has made extensive use of RTTC, and ATTC capabilities, personnel, and facilities during the performance of several aviation and missile prototyping tasks. The use of the test capabilities of these organizations verses the internal PIF development of these capabilities, is a prime example of the cost and capability trade-offs that the PIF has made to reduce costs. In addition, the PIF has formed strategic partnering relationships with both of these organizations to provide the test capabilities required for PIF aviation and missile prototyping tasks. The PIF has also utilized acquisition center personnel to award the PIF RAP contract. Through the increase in business, opportunities will provide for an increased level of support from this organization. It is envisioned that on-site, full-time requirements for acquisition personnel will emerge in the near future. The use of acquisition center personnel in a cost-reimbursable role will drastically challenge the operational process that currently exists in the acquisition center. The PIF also has opportunities to partner with NASA, particularly in the rapid, virtual prototyping, and materials areas. The PIF has initiated discussions with NASA personnel on both of these fronts.

- What is the relationship that exists with industry as a result of implementation of the AMRDEC prototyping strategy?

The PIF relationship with industry, since the implementation of the PIF concept in June 2002, has been very positive, despite the unique, and often misunderstood,

contractual mechanism that is in place. The PIF RAP contract, a ten-year, $1.1 billion instrument, provided for the inclusion of all levels of industrial participation including that of the OEM, capability-specific companies, service companies, and small businesses, through subcontractor arrangements with the JVYS, the prime contractor. The initial response from industry, when the PIF RAP contract was being formulated was, however, lukewarm at best. Many OEMs saw the PIF as a threat to their business base. Many of the other companies, both large and small, felt that there would be little opportunity for their participation. Once the PIF RAP contract was awarded and industry became educated in the mission of the PIF and the PIF RAP contract, an enormous amount of interest occurred from all levels of industry. Industry has been very supportive since the implementation of the PIF concept. In a four-month period, approximately $18 million has been awarded to several companies, at all levels. Many of the PIF industrial partners understand that, while they may not receive all taskings and associated funding for contracted prototyping efforts, they will benefit from the sheer magnitude of the PIF business.

- What cultural barriers were encountered during the implementation of the AMRDEC prototyping strategy and how were they overcome?

Their were, and still remain, many cultural challenges associated with the PIF concept implementation, the most significant of which remains the lack of understanding of the concept, due to its many facets, each comprised of their own distinct cultural challenges. Since the PIF concept is built upon a business foundation, it has, and will continue to be, a difficult concept to comprehend, since most Government organizations are deeply rooted in their traditional, bureaucratic environments. For instance, strategic partnering and leveraging of existing capabilities from other Governmental and industrial organizations is not an accepted philosophy at AMCOM, and has posed a tremendous challenge. The most effective means of mitigating this type of cultural resistance is to persevere to the point where initial positive results can be achieved. Success is the most effective means of changing culture. The initial successes of the PIF, since implementation of the entire concept, have served to change the culture associated with the traditional means of doing business. Other associated cultural challenges have and will continue to exist. Acceptance of the organizational structure of the PIF concept by

the workforce has been one such cultural inhibitor. The integration of two separate groups of personnel from two different organizations with distinctly differing cultures has required a vast amount of attention. Acceptance has been slow, but again, the successes achieved and the intense oversight from Engineering Directorate management, have overcome a portion of this cultural barrier.

- How does the AMRDEC prototyping strategy fit within the new Research, Development, and Engineering Command?

It remains to be seen what role the PIF concept might have within the AMC's RDE Command Agile Development capability, but there is tremendous opportunity for an exceptional fit. The PIF conceptual model is very appropriate to the charter of this AMC capability. The implementation of the AMC RDE Command Agile Development capability faces the same challenges as those faced by the PIF. These include infrastructure issues such as facilities and contact mechanisms, and more significantly, cultural issues, such as the acceptance of strategic partnering and leveraging of capabilities that exist throughout AMC and its industrial base. All of these issues must be addressed in order for this capability to support the mission of the AMC RDE Command to get technology to the warfighter more efficiently. The PIF concept and Engineering Directorate personnel expertise in this area, could serve AMC well as they continue to develop the Agile Development capability.

D. AREAS OF FUTURE RESEARCH

- How could the PIF concept maximize technology development and demonstration efforts to provide program managers objective assessment of technologies for potential weapon system insertion?
- How could the PIF concept partner with academia to develop technology and entry-level personnel with hard-to-find skills such as aerospace engineering, and software engineering?
- How could the PIF concept incorporate the capabilities within the AMC RDE Command more effectively?
- How could the PIF concept incorporate the capabilities of the Air Force, and the Navy?

LIST OF ACRONYMS

AACE	Army Aviation Corridor of Excellence
AED	Aviation Engineering Directorate
AH	Attack Helicopter
AMC	Army Materiel Command
AMCOM	Aviation and Missile Command
AMRDEC	Aviation and Missile Research, Development, and Engineering Center
AMD	Air and Missile Defense
ANSI	American National Standards Institute
ARC	Airborne Radio Communications
ATS	Air Traffic Services
ATTC	Aviation Technical Test Center
AWR	Air Worthiness Release
BCP	Battery Command Post
BGA	Ball Grid Array
BOD	Board of Directors
CAD/CAM	Computer Aided Design/Computer Aided Manufacturing
CARC	Chemical Agent Resistant Coating
CH	Cargo Helicopter
COR	Contracting Officers Representative
COTS/NDI	Commercial Off The Shelf/Non-Developmental Item
CPFF	Cost Plus Fixed Fee
CTR	Continuous Technology Refreshment
CXP	Common Transponder
DoD	Department of Defense

EAP	Engineering and Analysis Prototype
EGI	Embedded Global Positioning System, Inertial Navigation System
EIA	Electronic Industry Association
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESAM	Electronic, Simulation and Analysis Modeling
ESD	Electrostatic Discharge
FAA	Federal Aviation Administration
GFE/GFP	Government Furnished Equipment/Government Furnished Property
GOGO	Government Owned, Government Operated
HMMWV	High Mobility, Multi-Purpose Wheeled Vehicle
IDE	Integrated Data Environment
IPC	International Packaging Consortium
IMMC	Integrated Materiel Management Center
JVYS	Joint Venture, Yulista, Science and Engineering Services, Inc.
MOTS	Mobile Tower System
MWO	Modification Work Order
NASA	National Aeronautics and Space Administration
ODC	Other Direct Costs
OEM	Original Equipment Manufacturer
OSCR	Operations and Support Cost Reduction

PCO	Procurement Contracting Officer
PEO	Program Executive Office
PID	Prototype Integration Division
PIF	Prototype Integration Facility
PM	Program Manager
RAP	Rapid Acquisition Prototyping
R&D	Research and Development
RDE	Research, Development, Engineering
ROM	Rough Order Magnitude
RTTC	Redstone Technical Test Center
SESI	Science and Engineering Services, Inc.
SOW	Statement of Work
STC	Supplemental Type Certificate
T&M	Time and Material
TDEP	Technical Directive Execution Plan
TDP	Technical Data Package
TM	Tactical Missile
TTCS	Tactical Terminal Communication System
UAV	Unmanned Air Vehicle
UH	Utility-Helicopter
USAF	United States Air Force
VIZ	Visualization

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